AIAA

American Institute of
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Recommended Practice

Parts Management

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Abstract

This AIAA Standard establishes a parts management approach that is consistent with the new acquisition reform business environment. Acquisition reform as viewed by industry and government is a shift in business philosophy from a control paradigm to a performance based process. The explosive growth of the electronic commercial marketplace and corresponding decrease in aerospace and defense industry market share has caused the government and industry to seek alternative methods of managing parts for our aerospace and defense products. To develop a solution to this complex problem, industry and government teamed up to develop strategies for mitigating potential risks. The result of this team effort is a non-government standard (NGS) on Parts Management plan. The strategy is to manage risk up front by selecting the right part for the intent application. This approach is far more important than attempting to control all individual piece parts, especially in light of issues as parts obsolescence, diminishing sources and technology insertion. Ten key elements which need to be considered when selecting a part can be incorporated into a Parts Management. In addition, knowing your suppliers and the sharing of data encourages best value to performance, cost and schedule.

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Foreword

The Department of Defense (DOD) decision to reform its acquisition policies, and encourage the use of commercial components and Recommended Practices presents a challenge and an opportunity to the Aerospace and Defense industry. The DOD's blueprint for change, as mandated by the Secretary of Defense, is calling for the use of performance and commercial specifications in Defense Industry requires a baseline in a form of a Recommended Practice that ensures the performance, reliability, cost competitiveness, life-cycle projections, on-time delivery, manufacturing process controls and long-term viability of parts and materials.

The industry/government Part Acquisition Reform Team (PART) was formed to develop and maintain this performance based Recommended Practice to replace military specifications for parts and materials management. This initiative is a phased approach focused on an economic solution to manage the future direction of parts and materials acquisition.

During the second half of 1995, several prime aerospace contractors, subcontractors and suppliers joined in a consolidated team effort to evaluate parts issues such as deletion of specs and standards, parts obsolescence, and offshore manufacturing. Additional emphasis was placed on the development of criteria for proposal evaluation in a “spec-less” environment.

Senior members of the DOD and NASA have recommended that industry be responsible for the development of this Recommended Practice approach for parts and materials management.

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Comments and suggestions on the elements contained herein should be forwarded to the steering committee c/o:

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1.0 Introduction

1.1 Scope

This document is a collection of industry Recommended Practices for managing parts programs. It addresses the preferred program elements adopted by the aerospace industry (military, space and commercial) for parts management.

This document is written in general terms as a baseline for implementing a parts management program. It may be cited as a baseline within a statement of work and/or for assessing proposals and contractor performance. All levels of contractual relationships (acquiring activities, primes, subcontractors, and suppliers) may use this document. The approaches cover EEE (electrical, electronic and electro-mechanical) and mechanical parts. The user is responsible for integrating the elements of this Recommended Practice document appropriate to the program**.**

1.2 Purpose

The purpose of this Recommended Practice document is to assist contractors in the development of a parts management plan.

1.3 Background

Diminishing sources of military and space parts are leading to the use of commercial parts which will result in substantial non-recurring engineering (NRE) cost increases in current and future programs. The cost increases are incurred due to the need to establish a new reliability baseline through design, redesign or modification of current systems, analysis and test of systems and subsystems utilizing these commercial parts. The availability of radiation tolerant/hardened parts is most at risk.

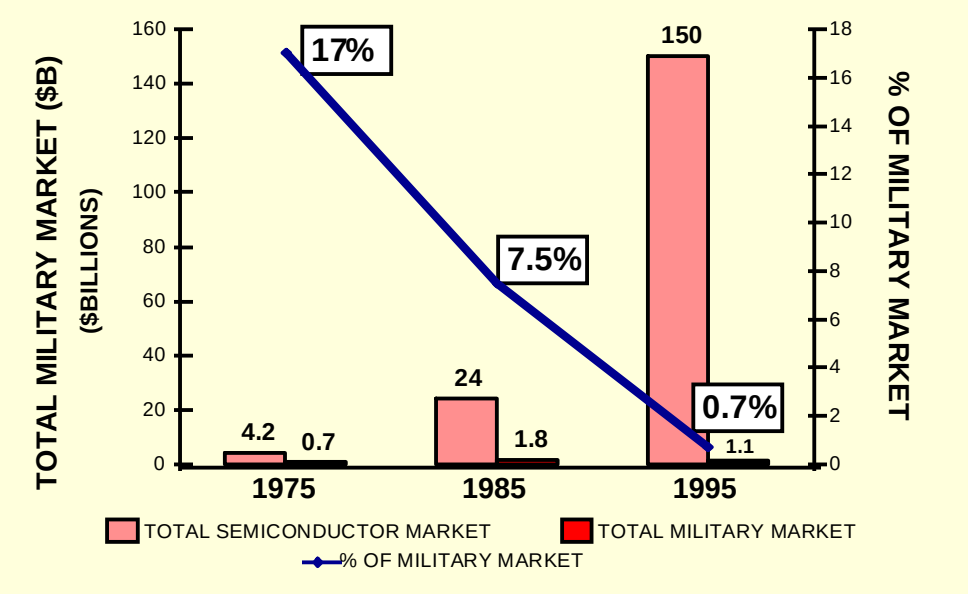
The trend of technology obsolescence and diminishing manufacturing sources of military and radiation hardened parts, materials, and equipment has been rapidly escalating due to a relative decline in the defense market coupled with the explosive growth of the commercial marketplace. Within the microcircuit industry, for example, military sales have declined from 16% to less that 1% of the total market (Figure 1). This shrinking market has prompted an increase in the number of products discontinued each year (Figure 2). As a result, industry has increasingly focused attention on issues of parts obsolescence affecting current development and production programs. Life cycles of new microcircuit technologies are rapidly shrinking (Figure 3) and in some cases, they are shorter than the time it takes to get a program through development into production.

1.4 Summary

In order to establish a government/industry parts management program consistent with the new acquisition reform business environment, and to address the issues and objectives noted previously, this Recommended Practice document addresses the following ten key elements:

- Part Obsolescence Management - minimize program disruption and ensure long term supportability throughout the program life cycle.
- Supplier Management - establish teaming partnerships with key suppliers to improve delivery and lower cost.
- Standard Supplier Assessments - eliminate redundant efforts and non-value added evaluations.
- Cost - realize significant cost reduction on existing and new programs.
- Technology Insertion - focus on utilizing technologies with lowest life cycle cost and maximum longevity.
- Communication Information Exchange - share contractor data via innovative concepts.
- Process Control - validate supplier techniques for monitoring critical manufacturing processes

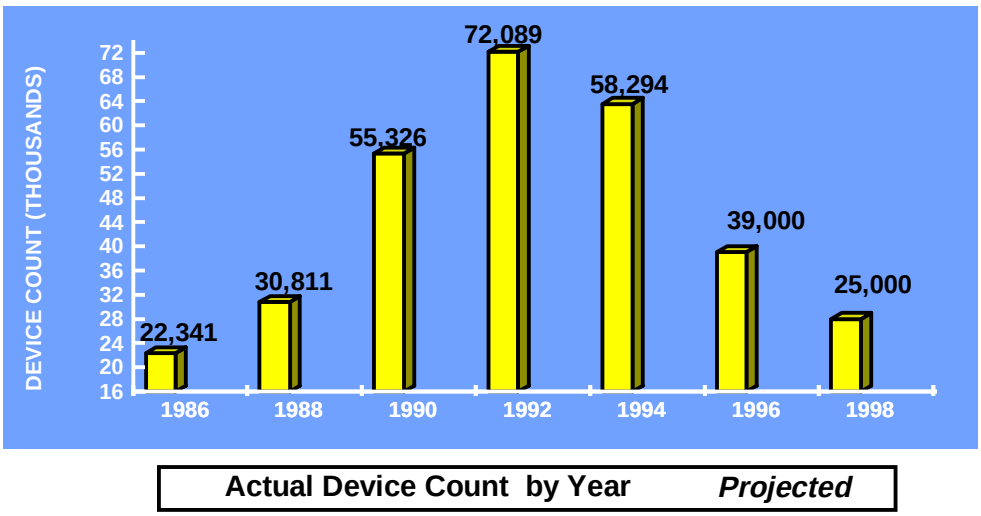
- Oversight - transition customer oversight to IPT insight and participation.
- Concurrent Engineering - encourage parts engineering participation in all phases of the product life cycle.
- Training - establish program awareness of reformed acquisition strategy throughout all levels of industry and government.



SOURCE :1995 INTEGRATED CIRCUIT INDUSTRY (ICE) & TACTech

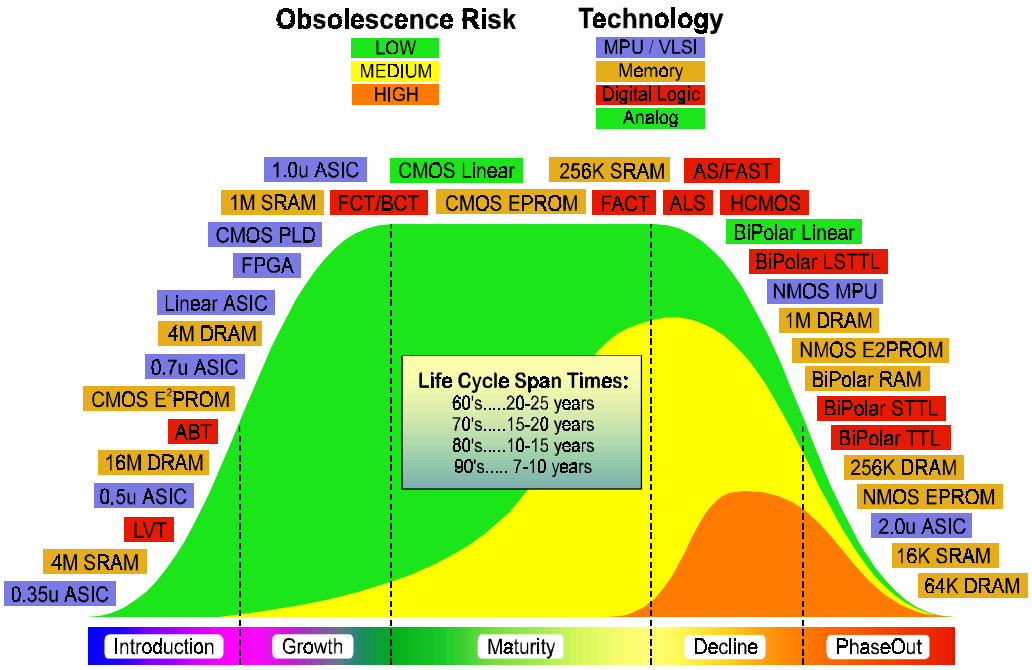
Estimates for FY2000 indicate military market share at less than 0.4% of the total market

Figure 1. Declining Military Market Share



Source: TACTech 12/95

Figure 2. Declining Military Microcircuit Availability



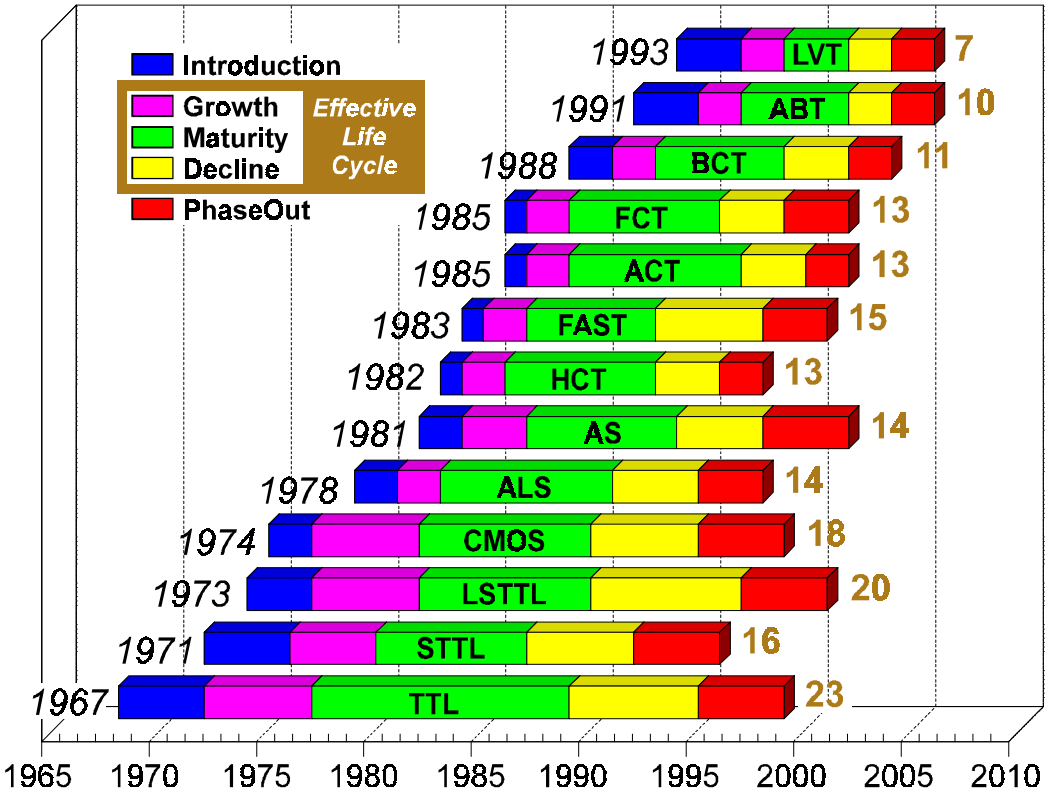


Figure 3. Reduction in Technology Life Cycles

2.0 Definitions and Acronyms

2.1 Definitions

Best practice

A product developed by industry and government IPT to document a consensus process to manage parts, materials and program “ilities”.

IPT Product

The product of the “best practice” design process is the bill of materials and documentation for the hardware described by the product specification

IPT

The integrated product team consists of members selected from the appropriate disciplines (e.g., component engineering, manufacturing, test, reliability, marketing, design, etc.)

Part

For the purpose of this Recommended Practice document, a part can be a sub-assembly, discrete component, NDI COTS, hybrid, etc.

Performance Specification

A document that defines what the customer desires as a product, its operational environments, and all required performance characteristics. This specification defines the performance requirements, not how to achieve them.

Product Specification

The document that defines the end item(s) the supplier intends to provide to satisfy all the performance specification requirements.

Standardization

Provides industry commonality to reduce inventories, minimize life cycle costs and ensure supportability through the use of shared qualification, reliability, performance assessments and common technology selection criteria.

Supplier

The entity that has a contractual obligation to provide parts, services or materials (e.g., subcontractor, vendor, distributor, manufacturer, etc.).

Technology Insertion Strategy

A decision making process to assess current and future part availability and technology trends, which leads to a decision regarding emerging or new technology insertion. This process is done in the concept development phase, but also impacts the production and field support phases.

2.2 Acronyms

AOQ	Average Outgoing Quality
ARN	Anticipated Reliability Number
ATP	Acceptance Test Procedure
BiCMOS	Bipolar Complimentary Metal Oxide on Silicon
BiMOS	Bipolar Metal Oxide on Silicon
CAM	Computer Aided Manufacturing
COTS	Commercial off the Shelf
DI	Dielectric Insulation
DM	Design Margin
DMSMS	Diminishing Manufacturing Sources and Material Shortages
DOE	Design of Experiments
DPA	Destructive Physical Analysis
DRAM	Dynamic Random Access Memory
ECL	Electron Coupled Logic
EEE	Electrical, Electronic and Electromechanical Parts
EMC	Electro-Magnetic Compatibility
EPINS	Electronics Parts Information Network System
ESD	Electro-Static Discharge
F^3I	Form, Fit, Function Interfaces
FMECA	Failure Modes, Effects and Criticality Analysis
FR	Failure Rate
GIDEP	Government / Industry Data Exchange Program
HAST	Highly Accelerated Stress Test
IPT	Integrated Product Team
MCM	Multichip Module
MOS	Metal Oxide on Silicon
NDI	Non-Developmental Item
NRE	Non-Recurring Engineering
PEM	Plastic Encapsulated Microcircuit
PPSL	Preferred Parts Selection List
PWB	Printed Wiring Board
RE	Recurring Engineering
SMT	Surface Mount Technology
SPC	Statistical Process Control
SQC	Statistical Quality Control
SOI	Silicon on Insulator
SOS	Silicon on Saphire
SSED	Space Systems Engineering Database

3.0 Parts Management Process

This *Recommended Practice* document has been developed to assist in dealing more pro-actively with critical parts and materials management issues and to provide guidance for developing comprehensive strategies to manage cost and schedule risk via an Integrated Product Team process (Figure 4). The main aspects of the Parts Management Process are: Design Process, Supplier Management, and Shared Data. The design process includes, but is not limited to, design margins, life cycle cost , technology insertion strategy, technical support, parts selection, and validation, which are addressed concurrently rather than sequentially. Supplier Management pro-actively selects and monitors the supplier base, while information generated from the design process and supplier management process is organized in a database that is shared with IPT members to reduce costs, and improve schedule performance.

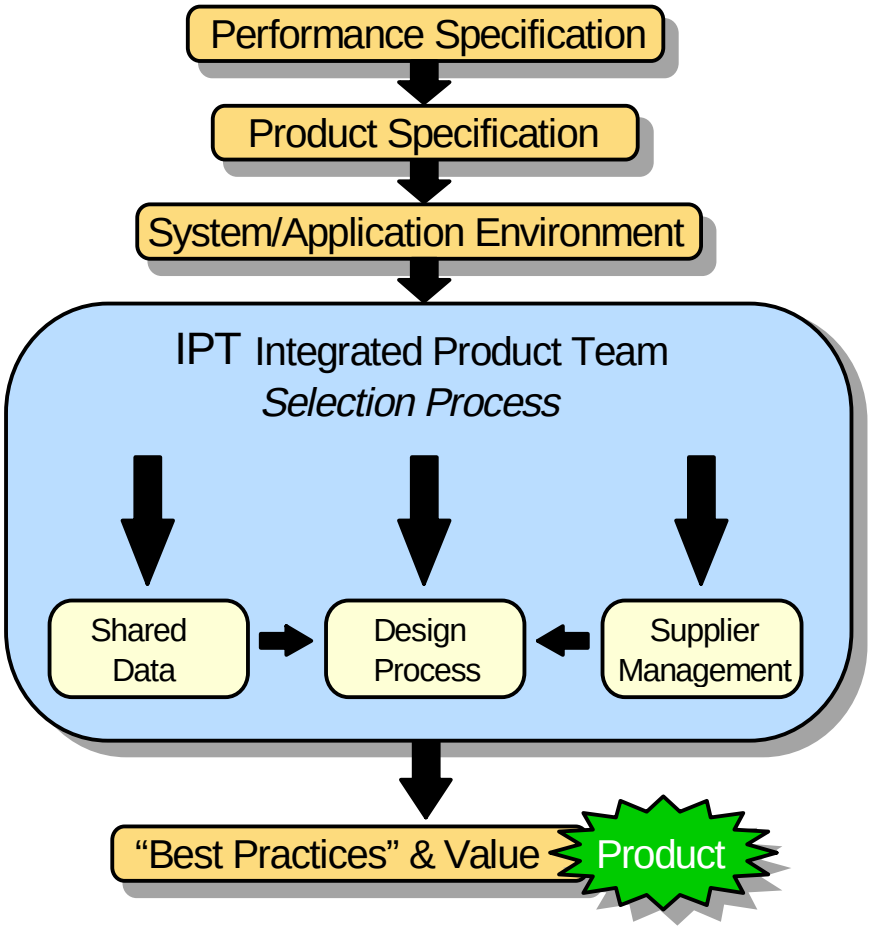


Figure 4. Parts Management IPT Overview

3.1 Design Process

The flow diagram (Figure 5) illustrates the interrelationships of the critical key elements that must be addressed concurrently by engineering and Supplier Management (B) to achieve the "best practice" selection of parts, materials, and documentation required for the design. The results obtained from analysis within some of the key elements should be made available as Shared Data (A). (Refer to Section 3.3). The following paragraphs are a description of these key elements.

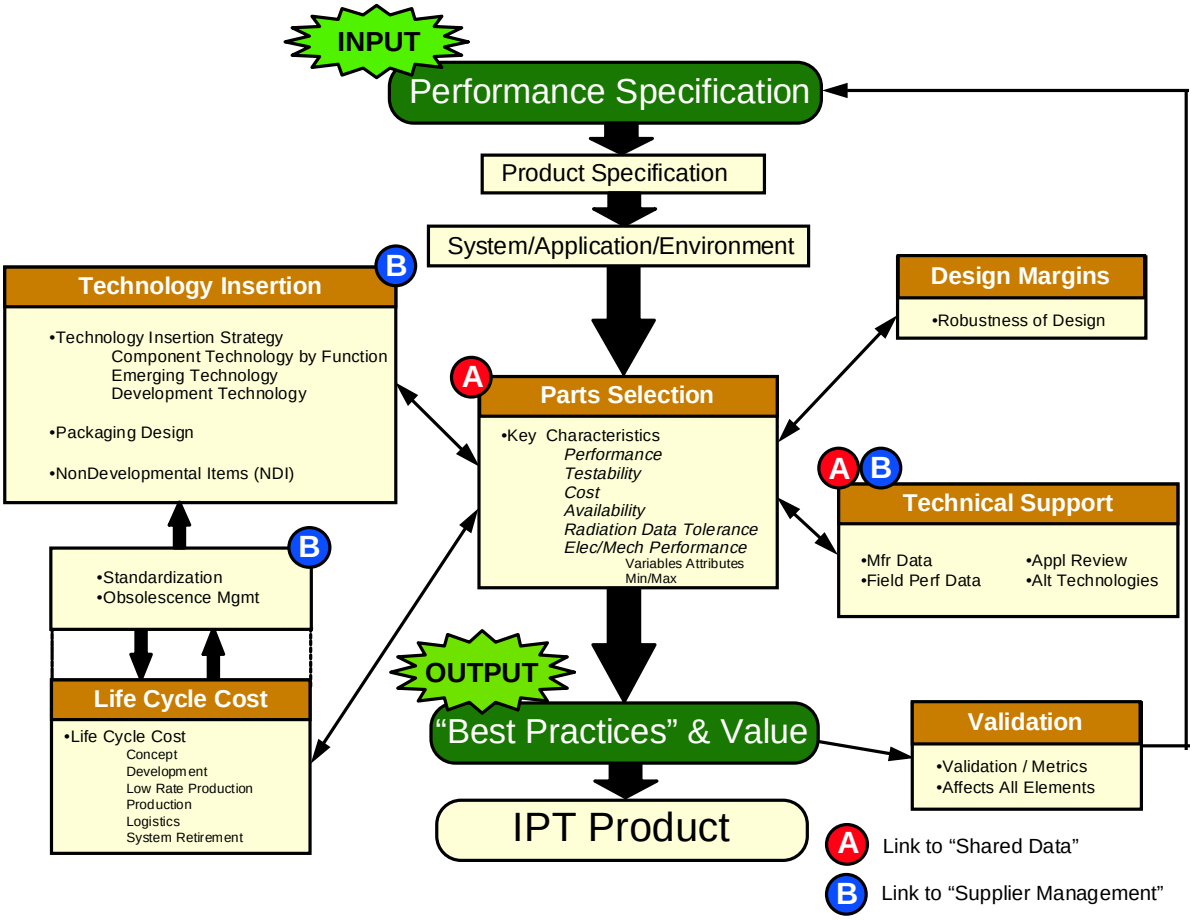


Figure 5. Design Process

3.1.1 Design Margins

The objective is to assist Integrated Product Teams with critical analyses resulting in a robust design and minimized life cycle cost. The availability of computer based analysis and simulation tools presents the opportunity to validate the detailed aspects of a design prior to manufacturing/qualification commitment. A design margin analysis based on actual conditions will combine a comprehensive description of piece part characteristics with simulation to ensure that system performance characteristics will be appropriate for the specific application.

The design margin process (Figure 6) describes a minimum set of analyses to maximize design robustness. Metrics to validate the process include, but are not limited to the following:

- *Comparisons of actual design margins to established baselines*
- *Quantity of engineering design changes*
- *Qualification test performance (failures)*
- *Yield prediction analysis (Cpk)*
- *Manufacturing/production yields (ATP)*

Associated elements are:

Parts Selection (Section 3.1.5)
Technical Support (Section 3.1.4)
System/Application/Environment

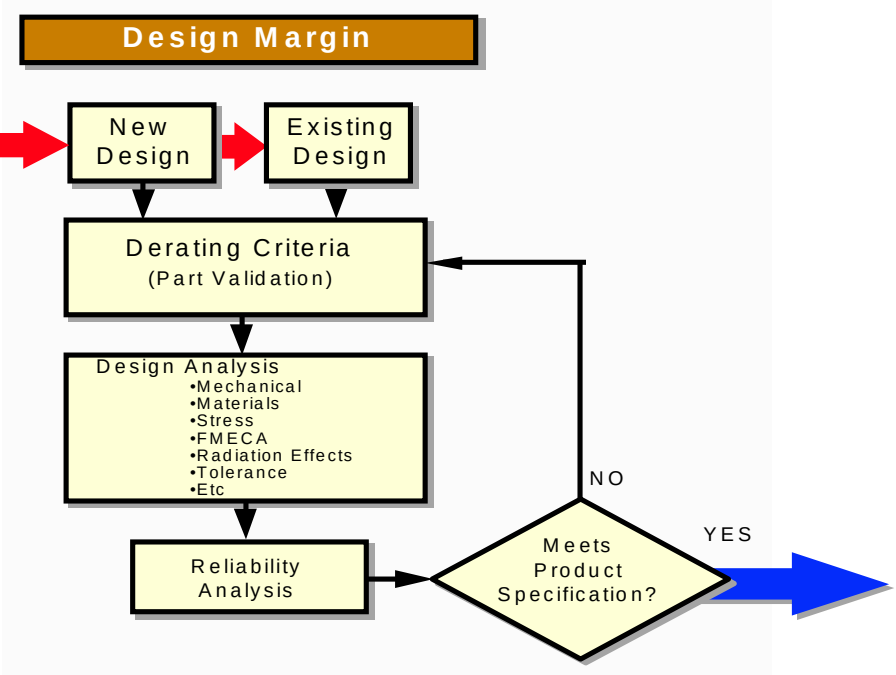


Figure 6. Design Margins

3.1.2 Life Cycle Cost

The objective is to provide methods for parts and materials standardization, identify technology assessment strategies and risk mitigation procedures to minimize program disruption due to part and material obsolescence and to define baselines to minimize costs throughout program life cycles (Figure 7).

Standardization techniques are becoming increasingly dependent on the available supplier base and market trends. New innovative ideas to move away from part and material number standardization to commodity/technology/family standardization provide a lower cost/higher benefit approach.

Factors to be considered include technology maturity, market base, material cost, ease of manufacture, performance management, logistics costs, standardization and Form, Fit, Function Interfaces (F^3I). Initial non-recurring costs must be de-emphasized and rationalized with long-term cost savings to provide the best value to the customer.

Through the implementation of technology assessments, strategic supplier relationships, technology leapfrogging, and creative risk mitigation techniques, program continuity can be maintained and life cycle costs minimized.

Validation of the life cycle cost objectives can be accomplished through the use of the following methods:

- Trade studies documenting part and material selection during design including all elements of cost through all program phases.

- Periodic program part and material technology assessments of life cycle ratings for obsolescence management.

- Periodic price trend analyses for “road map” technologies to validate that costs are declining as the technologies move from introduction and growth to production maturity in the market.

Associated elements are:

Parts Selection (Section 3.1.5)
Technology Insertion Strategies (Section 3.1.3)
Obsolescence/Standardization

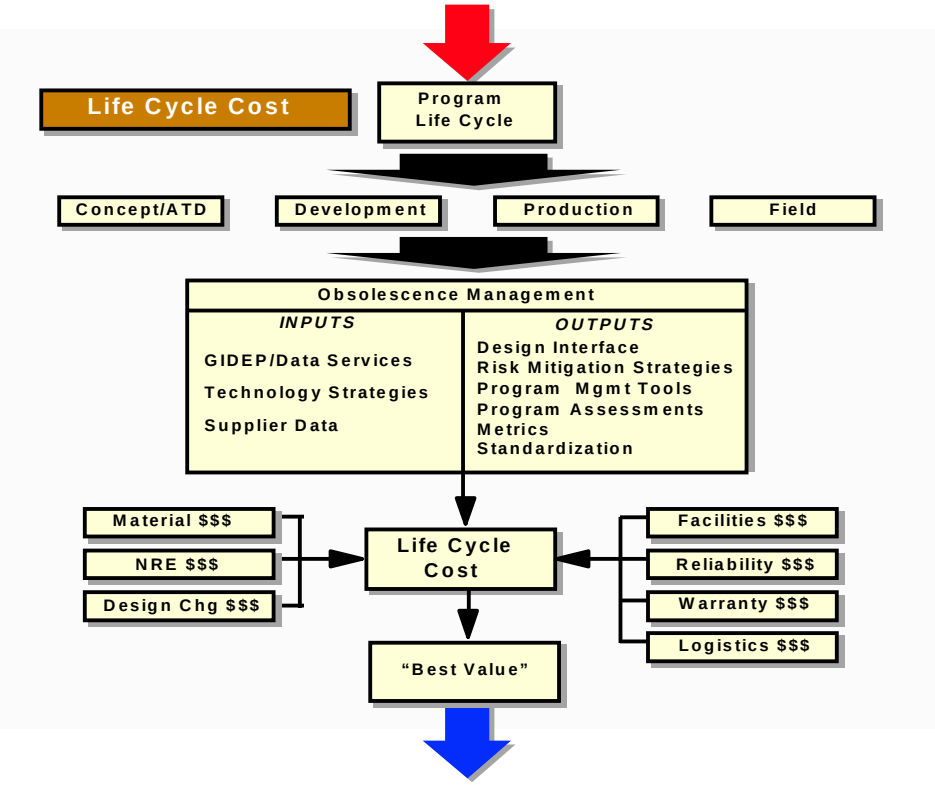


Figure 7. Life Cycle Cost

3.1.3 Technology Insertion Strategy

The objective is to create technology road maps which minimize risk of obsolescence and develop a strategy for technology insertion during the entire life cycle (Figure 8). The commercial industry is driving new technology development of parts and materials. The market dynamics of the industry (availability, functionality, performance, characteristics, and packaging) affect the way parts and materials are used in the design. Technology road maps subdivide technologies into functions that provide the required visibility to resolve future obsolescence and standardization issues. Use of technology road maps is the key element of the parts and materials selection process. Technology road maps must be assessed over the life of the program to validate their effectiveness.

Associated elements are:

Design Margin (Section 3.1.1)
Life Cycle Costs (Section 3.1.2)
Parts Selection (Section 3.1.5)
Obsolescence/Standardization

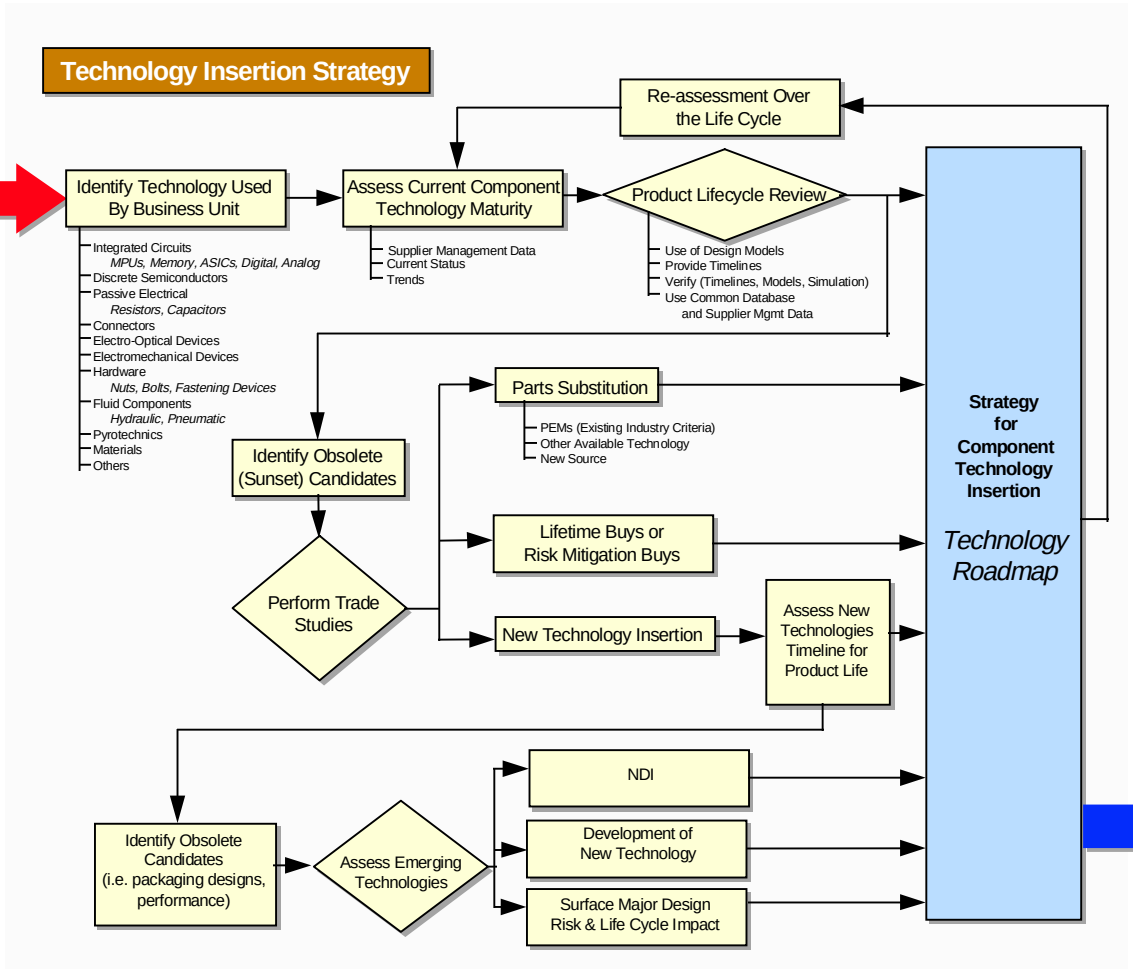


Figure 8. Technology Insertion Strategy

3.1.4 Technical Support

The management activity should provide data to facilitate reliability analysis, monitor applications, identify risk issues and suggest mitigation paths associated with the selected parts and materials (Figure 9) . Accomplishment of the performance objectives will be enhanced through the application of user and field reliability information from Shared Data. The Shared Data and Supplier Management information should be used in support of the IPT (Integrated Product Team) for evaluating sourcing, performance, packaging, and availability. Reliability models must be assessed over the life of the program to validate their effectiveness.

Associated elements are:

Design Margins (Section 3.1.1)
Parts Selection (Section 3.1.5)
Shared Data (Section 3.3)
System/Application/Environment

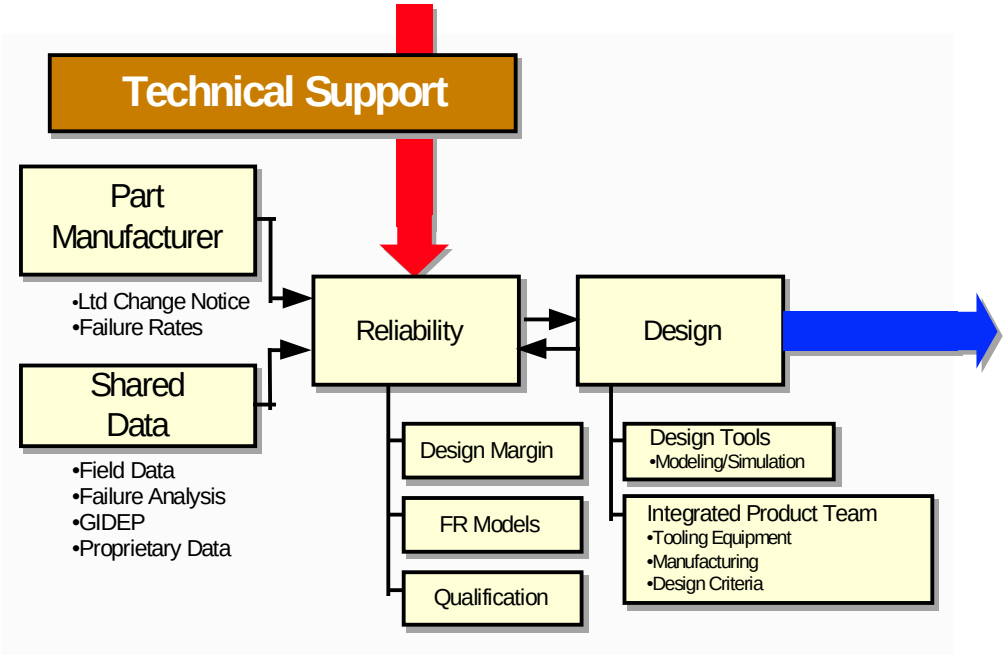


Figure 9. Technical Support

3.1.5 Parts Selection

The objective is to evaluate inputs from all key elements, then select the parts and materials that satisfy the product specification (Figure 10). The Selection Process is based on determining and assessing the key characteristics of the parts and materials that are under consideration. Use existing industry, government, and supplier databases, as established; where necessary, perform characterization testing. Parts and materials selected should be assessed for producibility and compatibility with the technology road map. The selection should be made after assessing testability, radiation tolerance (Appendix D), availability, cost and performance, etc. as appropriate.

Validation of the selection objectives can be accomplished through the use of a checklist (Appendix A) which ensures completeness of the selection data and results in a Òbest practiceÓ product..

Associated elements are:

All Key Elements (concurrently)

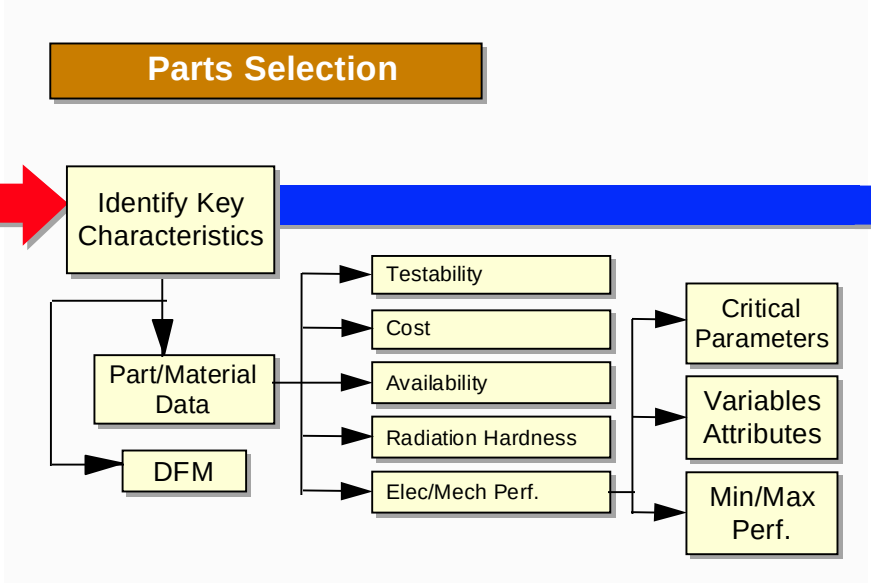


Figure 10. Parts Selection

3.1.6 Validation

Review of applicable process and procedure documentation to determine hardware conformance to the design specific requirements developed during the design process is an essential element of the parts management process. This validation provides the baseline for future change evaluations and performance improvement monitoring.

3.2 Supplier Management

Supplier management consists of a supplier selection and monitoring process in which a proactive approach is used to determine the capability and performance of a supplier on a continuing basis (Figure 11). The attributes of this process are described below in the Management Process, the Information Management process and the Internal Controls Section. This approach with the suppliers will enable a partnership in the form of IPTÕs (Integrated Product Teams), whereby each member will achieve their respective business objectives.

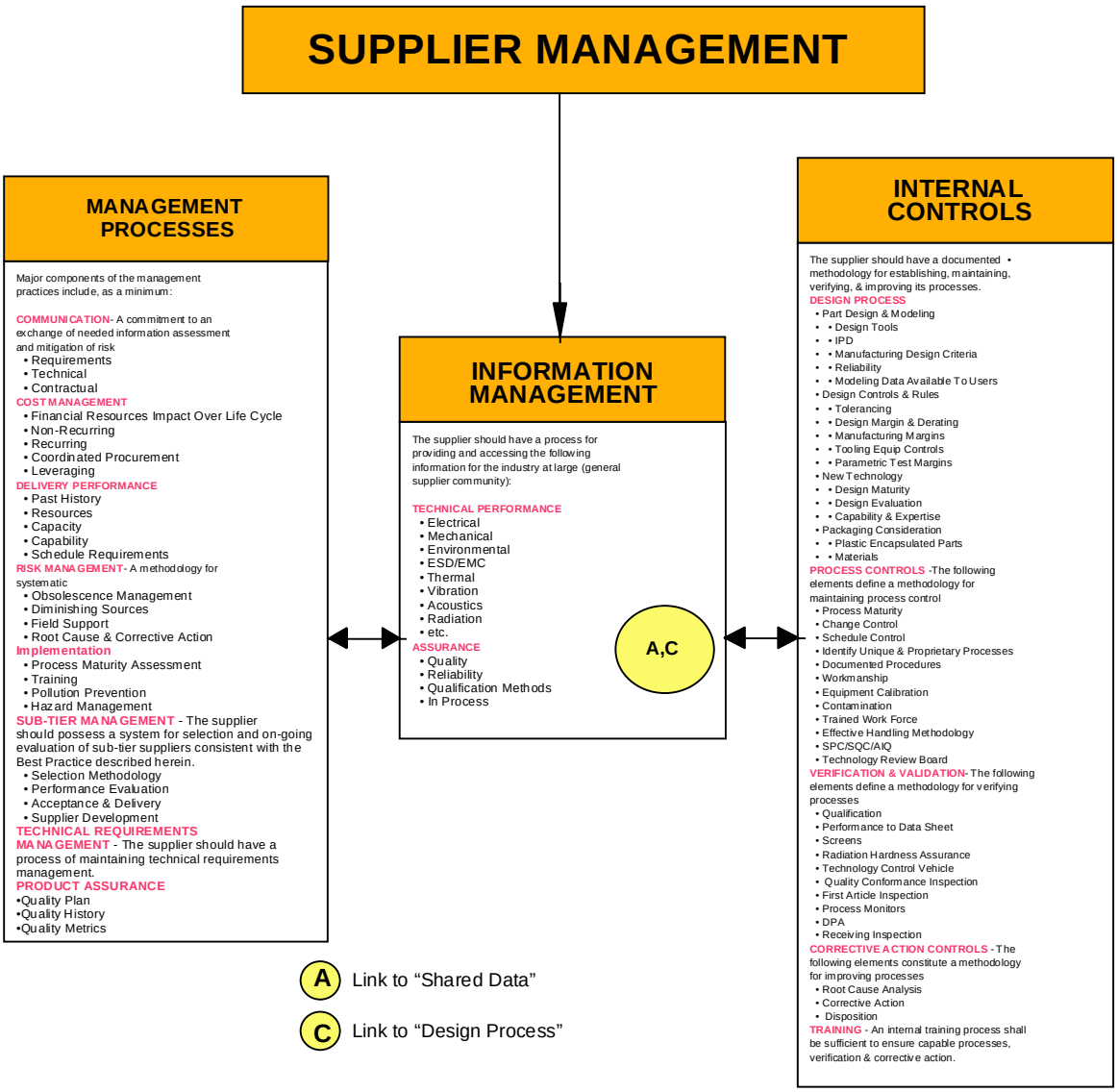


Figure 11. Supplier Management

Monitoring of the suppliers can be accomplished through on-site evaluations. Guidance for these evaluations is contained in Attachments I and II. These sample checklists are intended to be tailored specifically for the supplier and commodity being reviewed. The evaluators should be experienced and knowledgeable of the processes being reviewed. It is anticipated that Engineering and Quality Assurance will be represented. When practical, these evaluations will shared within industry (Refer to Section 3.3).

3.2.1 Management Processes

The objective is to ensure that the supplier has documented management practices which, as a minimum, must address: Communications, Cost Management, Delivery Performance, Risk Management, Sub-tier Management and Technical Requirements (Figure 11). Assessment of the supplier's management process should be performed periodically throughout the entire life cycle.

3.2.1.1 Communications

The supplier should have a process which facilitates the exchange of information on technical requirements, contractual issues and product performance.

3.2.1.2 Cost Management

The supplier should have a cost management process that addresses financial resources, life cycle costs, recurring and non-recurring costs. The management process should have a cost reduction activity (i.e., a coordinated procurement leveraging).

3.2.1.3 Delivery Performance

The supplier should have a process which demonstrates the ability to manage their delivery schedules based on past history, current and projected resources, capacity and capability.

3.2.1.4 Risk Management

This process should include, as a minimum, the ability to assess risk at the mission/system level through the lowest piece part level, as applicable. The supplier should have a risk management system capable of performing root cause analysis, process maturity analysis and corrective action implementation. Examples of risk include, but are not limited to, obsolescence, health and safety hazards, diminishing sources, process changes and facility moves.

3.2.1.5 Sub-Tier Management

The supplier should maintain a process for the development, selection and ongoing evaluation of sub-tier suppliers, consistent with the practices described herein. The selection methodology should be based on evaluation of the sub-tier suppliers' application of this Recommended Practice. The evaluation should assess the sub-tiers' capability to deliver on time, within cost, and per the specified requirements.

3.2.1.6 Technical Requirements Management

The supplier should maintain a process for the management of technical requirements. Examples of technical requirements are part design, modeling, design controls, design rules, packaging requirements and life cycle considerations.

3.2.1.7 Product Assurance

The supplier should have a documented management process which ensures the program product assurance requirements are achieved throughout a program's life cycle. The product assurance process should monitor and provide quality history and quality metrics information.

3.2.2 Information Management

This process should provide technical information for distribution to the industry and government (Figure 11). Refer to Shared Data (Section 3.3). The supplier should have an information management process for distributing and reporting technical and assurance information. Additionally, the supplier should provide support for their commodities. Product information should contain such items as electrical and mechanical characteristics, environmental capabilities and unique characteristics such as Electrostatic Discharge (ESD) susceptibility, radiation hardness (Appendix D), reliability and quality data.

This information, as a byproduct of the design activity, is not only shared with the industrial community, but, is fed back to the supplier's own activity and, in turn, may be used by that activity to enhance the design.

The supplier should have a system for assembling and maintaining technical information as well as a process for accessing the Shared Data (Section 3.3).

3.2.3 Internal Controls

The supplier should have a documented methodology for establishing, maintaining, verifying and improving its processes (Figure 11). The application of internal controls and their sub-elements should be based upon the design and product maturity as it varies within the life cycle.

3.2.3.1 Design Process

The supplier should have a systematic design methodology that is capable of meeting the performance, reliability and quality requirements as delineated in Section 3.1 (Design Process). The components of the methodology may include design and modeling, design controls and rules, F^3I, technology insertion, and provide for new packaging designs, as appropriate.

3.2.3.2 Process Controls

The supplier should have process controls in place to assure consistency in quality, reliability and performance of the product. Specific process controls will depend on the type of product. Examples of the process controls include, but are not limited to, workmanship, calibration, SPC (Statistical Process Control), change control, etc.

3.2.3.3 Verification and Validation

The supplier should have a methodology to verify and validate that the product meets the requirements. These methods may include, but are not limited to, screening, qualification testing, quality conformance testing and first article inspection. Special testing, such as for radiation hardness assurance (Appendix D), may also be required .

3.2.3.4 Corrective Action Controls

The supplier should have a closed loop corrective action control system sufficient to identify the root cause, as well as implement the corrective actions and monitor the results.

3.2.3.5 Training

The supplier should have a continuing process to provide effectively trained resources on the various processes required to produce a quality product and verify its integrity.

3.3 Shared Data

A key to improvement in the design and development process is the ability to share information among the various IPT's at the primes, subcontractors and suppliers. The shared database(s) is a tool which will significantly enhance the program performance goals in terms of cost savings, and schedule improvement associated with implementation of this Recommended Practice document.

The design and cost benefits of emerging technology and commercial parts can only be fully realized if the data required for their potential use in all environments is developed and documented in a rapid manner. This can best be accomplished by industry support of a shared database(s).

The development and use of industry wide shared databases will reduce the life cycle cost associated with redundant testing and qualification, and lead to a higher level of standardization and life cycle program protection.

3.3.1 Data Flow

The following is a depiction of the envisioned database for parts and materials used in the design and support of new and fielded systems (Figure 12).

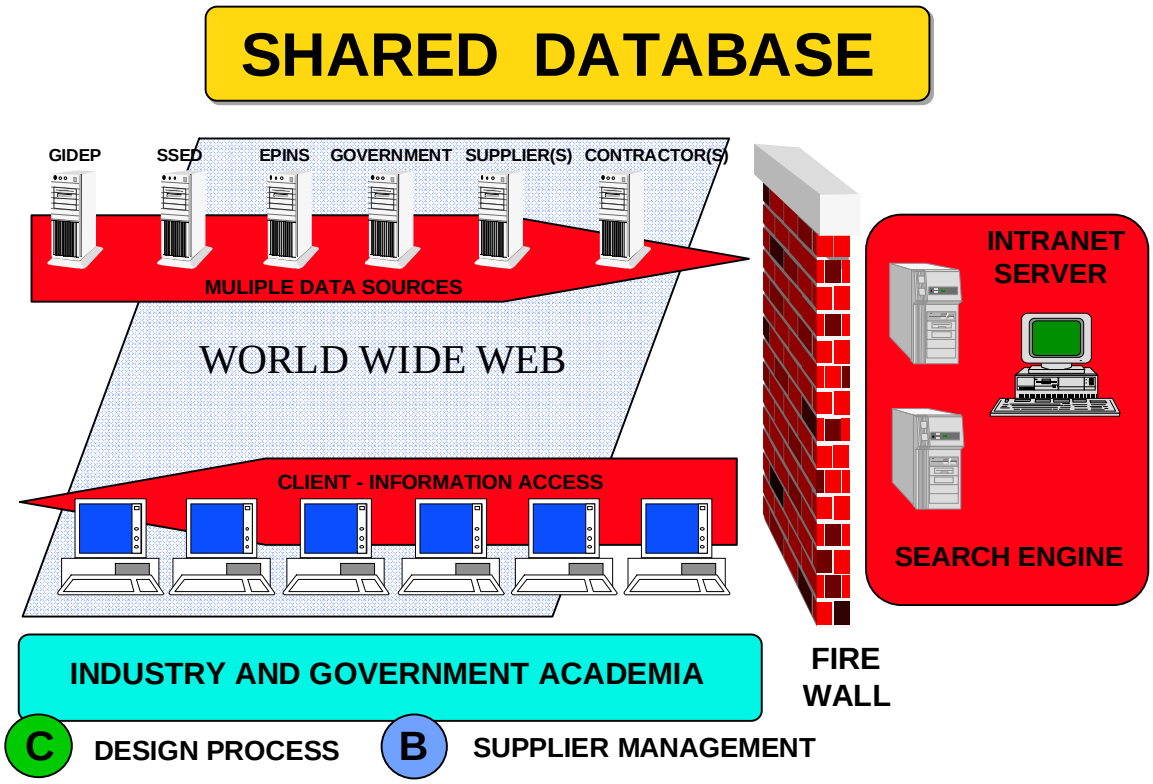


Figure 12. Shared Database Process Flow

3.3.2 Key Attributes

The key attributes of the database(s) must include, but are not limited to, the following.

- Dial-up or Network Access
- PC-Based Access (Desktop) Searchable on any field
- Access speed
- Password Protection (Privileges)
- Two Types of Data
  - Primary
  - Pointers (Can be Coupled)
- Wild Card Features
- Help features On-Line
- On-Line Tutorial
- Windows Environment
- Bulk Up load/ Down load
- Data Portable
- Upgradeable (Hardware & Software)
- Alert Messages

3.3.3 Data Elements

The following data elements are used in the Recommended Practice design process.

Federal Supply Code
Part Number
MIL Part Number
Unit Name
Replacement Part Number
Approved Name
National Stock Number
Descriptive Data
ARN (Failure Number)
Lot Date Code
Locator Designator
Unit Serial Number
Phone Number of Part Manufacturer
Cost
Temperature Range
Qualification Level
Information Supplied by Whom?
DPA-Phase II Narrative
RAD-Phase II Narrative
Failure Analysis
Field Failure Data
Generic Part Number
Part Number Type
Part Manufacturer
Program Short Name
Replacement Cage Number
Program Used in Comments
Standardization Phase Code
Failed Part Type
Abstract
Part Serial Number
Unit Part Number
Address of Part Manufacturer
Codes for Procurement
DMSMS
Function
Package Type
DPA-Phase I Flag
RAD-Phase I Flag
Supplier Assessment
Failure Rate Calculations
Test in Process-Flags

3.3.4 Data Standardization

Standardized data is needed for the following elements: subcontractor assessment, supplier assessment (Attachments I and II, respectively), radiation testing (Appendix D), failure reporting and analysis, qualification data and minimum upscreen and destructive physical analysis (DPA) testing. Figure 13 depicts a process flow for populating test data or test reports into a database source. This process flow shows where standardization for inputting data could be used.

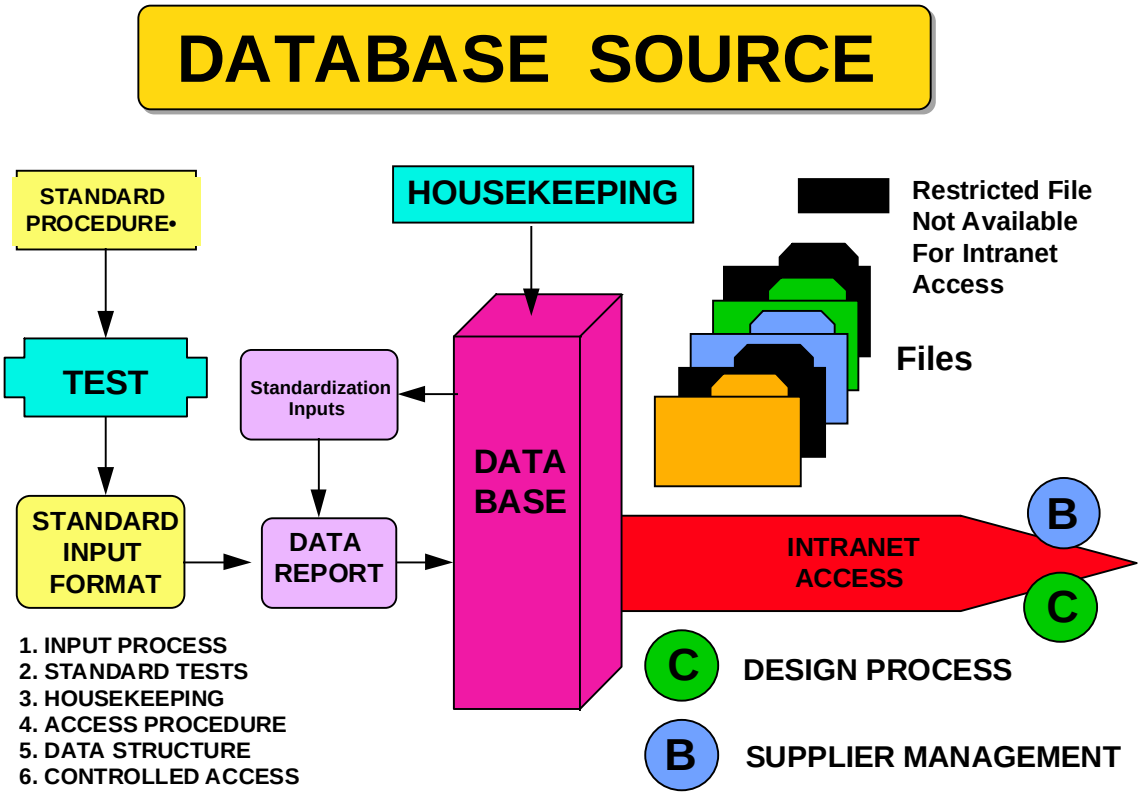


Figure 13. Database Source Process

3.3.5 Recommended Practice Application and Database Support

The following indicates contractor, sub-contractor and supplier utilization of the Parts Management Recommended Practice selection process by demonstrating the following elements.

- Access and participation in a government/industry shared database.
- Use and implementation of shared data for performance allocations, design, evaluation, cost benefit analysis, risk mitigation, and subsystem reliability and margin assessment.
- Use of shared databases to implement procurement, test, qualification, inspection, logistics/life cycle support.
- Use of shared database to establish obsolescence planning.
- Use of the shared database to evaluate the maturity and application of new technologies.
- Implementation of Recommended Practice that ensures data integrity for design, test, usage, environmental, qualification, and other key data elements to be entered into the database.
- Implementation of metrics that provide trend data for parts and methods for industry/government sharing of quantitative data on a controlled and validated basis.
- A process that encourages supporting parts suppliers and second source suppliers to participate in and support of the a common database.

4.0 Quality Assurance Provisions

Quality assurance is a combination of the design process validation (Section 3.1.6 and 3.2.3.3) and product assurance (Section 3.2.1.7). Users of this document should define the approach and methods to be used in implementing all of the program elements

Appendix A. Parts Selection Checklist

- Review Performance Specification

- Product Specification
  - Provide parts requirement
  - All levels of application (environments)
  - Maintain traceable documentation from performance specification to part level

- Generate Parts Control Plan

- Technology Insertion Strategy Decision Process

- Assess Current Technology
  - Highlight part issues/risks

- Obsolescence Risk Mitigation Plan
  - Life of Type Buy
  - Assess alternatives

- Provide Decision for New Technology
  - Assess technology / road map
  - Can require emerging technology

- Highlight Technology Strategy and Obsolescence Impact
  - Impact on life cycle cost

- Evaluate Design Process / Design Margin

- Initiate Parts Selection Process

- Identify the Bill of Material, Risk Issues
  - Redesign
  - Emerging technology
  - Availability

Appendix B. Recommended Practice Example

The purpose of this appendix is to illustrate the concepts described in the design portion of the Parts Management Recommended Practice by applying them to the selection of an actual part. The part selected for this example is a 16 Megabyte DRAM chip that is to be applied as an element of a Multi-Chip Module (MCM).

Much of what happens in the design portion of this practice occurs simultaneously. All of the key elements are related to each other to some degree. For this reason, the process does not lend itself well to flow charting or a "cookbook" description. This example will illustrate activities that take place in each key element of the process and how they are integrated together in the parts selection process. The example cited here takes place in an Integrated Product Team (IPT) environment using concurrent engineering techniques to satisfy the requirements of a performance specification.

Performance Specification

The customer issues a spec for a system which describes what the system must be able to do. System is defined listing performance requirements: Size, weight, reliability, cost power output, detection range, etc. The spec does not tell the contractor how to achieve these requirements.

Product Specification

The contractor evaluates the performance spec and then allocates the requirements in the form of a product spec. The product spec describes the contractor's product and requirements traceable to the performance spec.

System/Application Environment

The environmental conditions in which the product must function are described in the performance spec and flowed down or allocated to lower levels of assembly. Thus, a part's minimum and maximum operations temperature are required to satisfy the requirements of the system within its environmental limits. There are no arbitrary requirements like, all microcircuits must be of full military temperature range -55C to +125C.

Design Margins

Design margins are established to ensure a robust design. Derating criteria and design analysis are applied to the design to ensure the system will perform within specified limits when operated at environmental extremes. Design margins impacted the selection of our example 16 Megabyte DRAM in the following ways:

- Timing analysis of a circuit dictated the access time of a part had to be between 50 and 100nS (allowing 20nS margin)
- Thermal analysis dictated min. and max. temperature requirements were -40C to +85C (allowing 15C margin on the low side and 40C on the high side)

Technical Support

The designer specifies the requirements for individual parts. These requirements are flowed down from the performance spec through various levels of product specs. The selection of the 16 Megabyte DRAM was determined by these aspects of the reliability process:

- Reliability of an assembly is related to the number of interconnects and the total number of parts per assembly
- By selecting the largest available device (16 Megabyte) the interconnect and part counts were minimized and reliability prediction maximized.

Furthermore, reliability and yield data were obtained from the part supplier to input into the reliability, producibility and design to cost models.

Life Cycle Costs

When designing a system, it is important to consider life cycle cost through concept, development, production and field support. When selecting a part, one must consider the non-recurring design costs, the recurring material costs, and the production and support costs. Each of these costs must be balanced against the other to identify the optimum part for the application. Whatever device is selected must satisfy the design to cost model for the system.

In the case of the 16 Megabyte DRAM, the design to cost model provided a target cost for the part. The part could be purchased for the target cost only if it was purchased without extensive screening. An analysis was performed to determine if unscreened chips would provide adequate manufacturing yield or if it was more cost effective to buy known good chips at a higher unit cost to boost production yields. The supplier provided yield and characterization data indicating known good chips which were less cost effective than unscreened chips. The cost and yield predictions were fed into the updated design to cost module.

Because it was known that the DRAM would become obsolete early in the production phase, strategies to mitigate this risk were developed and their costs were included in support and warranty pricing.

Technology Insertion Strategy

The technology insertion strategy is a process for assessing the current and future part availability and technology trends. This strategy is applied in the development phase and is periodically updated throughout the life of the program.

In our example, the current technology was assessed by consulting the preferred parts selection list. The prefered (PPSL) listed a 4 Megabyte DRAM as the standard memory device. The standard 4 Megabyte was determined to be unsuitable for the application due to its size to capacity ratio and its impending obsolescence. Although standardization is a goal, it is only one facet of the overall suitability of a part. A trade study was performed and the 16 Megabyte DRAM was selected as the best balance of Life Cycle cost, performance, and reliability. A 32 Megabyte device was considered but determined to not be far enough along in its technology life cycle to be incorporated into this design. Because of the short Life Cycle of memory devices, long term availability was a concern. We should count on several die shrinks during a DRAMs short Life Cycle. To compound the problem, the production life of the system is 10 years or more; for this reason, it is necessary to
develop a long term strategy or road map to mitigate cost and schedule risk. By consulting with the part supplier and evaluating industry trends, we were able to predict that the 16 Megabyte part would become obsolete at about the time the system was entering production. With this knowledge, we are able to plan procurement and design the strategies to address the problem. Options include, waiting for the optimum price and making a multi-year or lifetime buy, redesigning the substrate in the future to accept later generation chips, or completely redesigning the using assembly to incorporate future technologies now in development. These options must be fed into the overall technology insertion strategy, Life Cycle cost models, and warranty pricing. Ideally there should be a long-term technology and obsolescence plan laid out for the life of the program.

Parts Selection

Parts selection is the process of evaluating the characteristics of candidate parts, comparing them to the requirements of the application, and integrating inputs from the key elements of Life Cycle costs, technology insertion strategy, design margins, reliability, and design. Ideally, this is done concurrently within an Integrated Product Team (IPT).

In the case of the example 16 Megabyte DRAM, an IPT composed of component engineering, circuit design, mechanical engineering, production, materials & processes, design to cost, reliability, quality assurance and the supplier met to perform a trade study and selected the part which would provide the optimum balance of cost, performance, and reliability. The team verified the part met all of the application requirements, met design to cost criteria, and was producible.

Appendix C. Obsolescence Technology Assessment Examples

INTRODUCTION

Periodic technology assessments are the cornerstone of an effective obsolescence management program. The examples herein illustrate technology assessments performed at various levels of design from component through to system level. These examples indicate that what is a 10% obsolescence problem at the component level becomes a 37% problem at the next assembly level and affects 50% of the subsystems in the end item (system level). What is important to note is that assessments should be performed at all levels of design and not just focus on component-level issues. By evaluating at subsystem and system levels, risk mitigation strategies can be developed which provide a “best value” solution to the program.

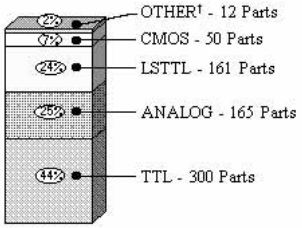
Obsolescence Technology Assessments

MICROCIRCUIT TECHNOLOGY ASSESSMENT
OBSOLESCENCE MANAGEMENT

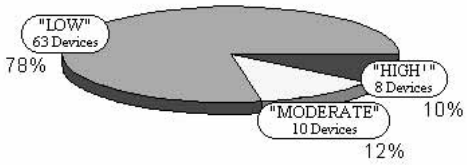
Component Level

Total IC Types Used / System: **81**
Total IC Quantity: **688**

TECHNOLOGY BREAKDOWN



OBSOLESCENCE RISK

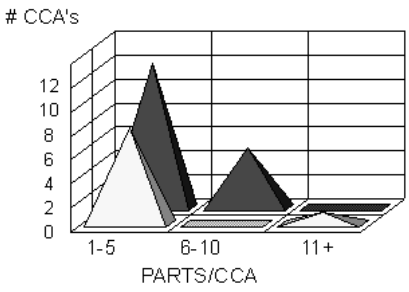


MICROCIRCUIT TECHNOLOGY ASSESSMENT
OBSOLESCENCE MANAGEMENT

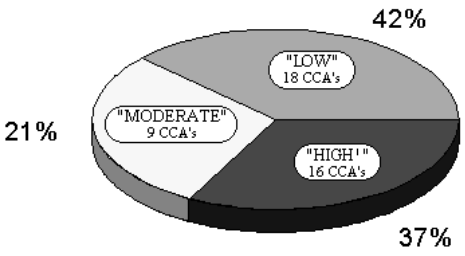
Assembly Level

Total CCA's / System: **43**
Launcher-**29**, Missile-**4**, Ground Support Equipment:-**10**

COMPONENT USAGE RATES/CCA

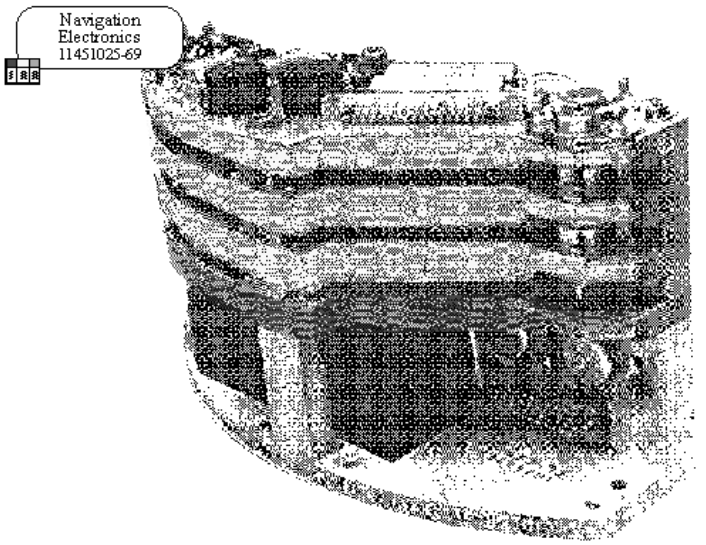


OBSOLESCENCE RISK



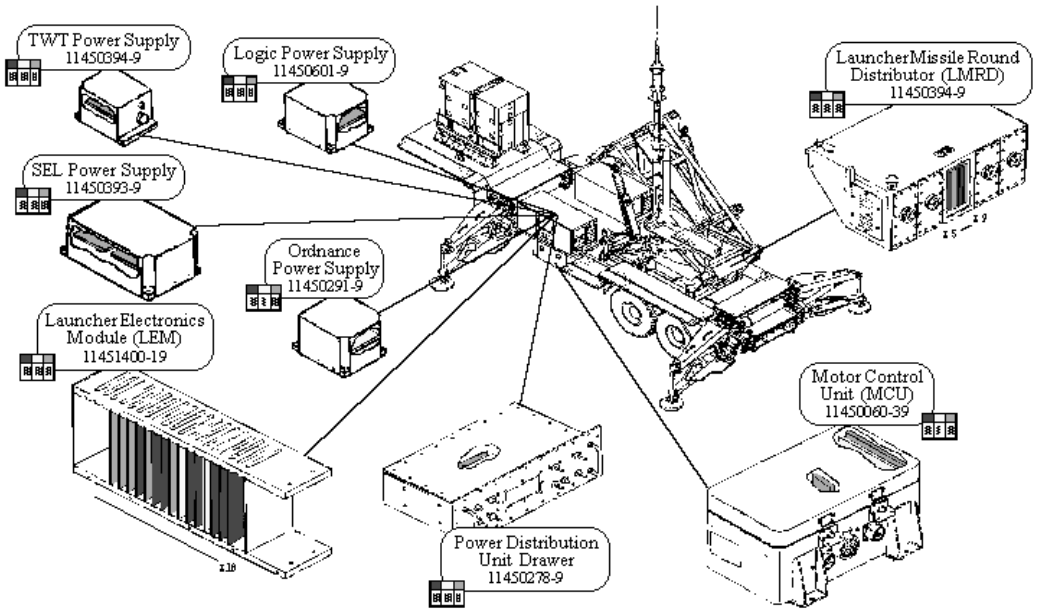
MICROCIRCUIT TECHNOLOGY ASSESSMENT
OBSOLESCENCE MANAGEMENT

Subsystem Level



MICROCIRCUIT TECHNOLOGY ASSESSMENT
OBSOLESCENCE MANAGEMENT

System Level



Appendix D. Radiation Effects

This appendix provides radiation hardening guidance to the Design Process IPT by addressing the concerns and issues necessary to survive radiation environments. Some of these issues include, but are not limited to, total ionizing dose, dose rate, neutrons, electrons, protons, heavy ions, etc.

System/Analysis/Environmental

Radiation effects are application dependent. Table I shows the typical radiation environmental effects, by application. The precise level of each type of radiation environmental effects typically flows down from the system performance specification. The flow-down may involve some analysis. Definitions of each of the radiation environmental effects used in Table I are presented below.

Table I - Application/Environmental Effects Radiation Issues

Applications	Environmental Effects					
	Total Dose	Displacement Damage	Dose Rate	SEE	EMP (all types)	Spacecraft Charging
Military						
Ground	X	X	X	-	X	-
Air	X	X	X	X	X	-
Space	X	X	X	X	X	X
Commercial						
Ground	-	-	-	-	-	-
Air	-	-	-	X	-	-
Space	X	-	-	X	-	X

Total Dose (also called Total Ionizing Dose) is the cumulative ionizing radiation which the part experiences during its mission life. Examples of contributing sources, from either natural causes or man made events, are gamma rays, x-rays, protons, electrons, neutrons and heavy ions (cosmic rays).

Displacement Damage is a semiconductor and material failure mechanism caused by neutron fluence and/or proton fluence. The neutron fluence is usually man made radiation source generated by nuclear weapons. The proton fluence is a naturally occurring phenomenon that is typical in some critical orbits in space.

Dose Rate is a prompt ionization dose delivered in a very short amount of time resulting from a man made nuclear event. The major contributors are gamma rays and x-rays.

SEE (Single Event Effects) are comprised of Single Event Upset (SEU), Single Event Latchup (SEL), Single Event Burnout (SEB) and Single Event Gate Rupture (SEGR). These effects result from a heavy ion or other charged particle traveling through an active area of a semiconducting device depositing sufficient charge to cause one or more of the effects described above to occur.

EMP (Electromagnetic Pulse) is electromagnetic radiation generated by the interaction of gamma radiation produced by a nuclear explosion with the atmosphere or conductive material in space. Some of the types of EMP are:

- SGEMP
- DEMP
- HEMP

Spacecraft Charging is typically a natural occurring build-up of electrons between two types of material or physical structure in space that may exhibit electrostatic discharge (ESD).

Table II shows the various radiation environmental effects that could be specified in the performance specification. It gives the part and systems effects tat could occur in each environment and shows the mitigation approaches that can be used to lessen the effect of each environment. Analysis may indicate that one or more of the mitigation approaches is required in order to reduce the radiation susceptibility to an acceptable level.

Table II. System and Part Radiation Effects and Examples of Mitigation Approaches

Environmental Effects	Part Effects	System Effects	Mitigation Approach Examples				
			PS	CD	SH	MP	HA
Total Dose	Critical parameter degradation to failure	Performance degradation to failure	x	x	x	x	x
Displacement Damage-Neutrons			x	x		x	x
Displacement Damage-Protons			x	x		x	x
Dose Rate	- Upset in logic state - Latchup - Burnout - Gate Rupture	- Upset - Latchup - Failure	x	x	x		x
Single Event Effects			x	x		x	
EMP	Upset or burnout	Upset Failure	x	x	x		
Spacecraft Charging		ESD		x	x	x	

Where,

PS = Part Selection, e.g., Radiation Hardened, Radiation data showing tolerance, etc.

CD = Circuit Design Approach, e.g., Biasing techniques, Larger design margin, etc.

SH = Shielding (Space application), e.g., Spot Shielding, Structural Shielding, Shadowing, etc.

MP = Mission Profile, e.g., Redundancy, Fault Tolerance, Orbit, etc.

HA = Hardness Assurance Controls, e.g., Radiation Lot Acceptance Tests (RLAT), 100% Dose Rate Upset Testing, 100% Latchup Testing, etc.

Design Margin

The robustness of the design is often determined by the design margin process as shown in Figure 6 of Section 3.1.1. Technical support and design information (e.g., critical design parameters, tolerances, allocations, etc.) aids in this process. Some types of analysis used to determined a design margin are shown below:

- Circuit Analysis
- Shielding Analysis
- System Analysis
- Part Radiation Data Analysis
- SEU Analysis

One example of a design margin validation criteria is shown below:

- High DM -> Acceptable
- Low DM -> Hardness Assurance Controls

Parts Selection

Parts and materials can be selected for radiation hardness in the following ways:

- Radiation Hardened Parts
- Design Baselines
  - Program Tailored
- Part Type Deratings
- Radiation Data Available
- Low SEU Rates
- Part Testing
- Radiation analysis
- Exhibit High Design Margin
- Lifetime Buys

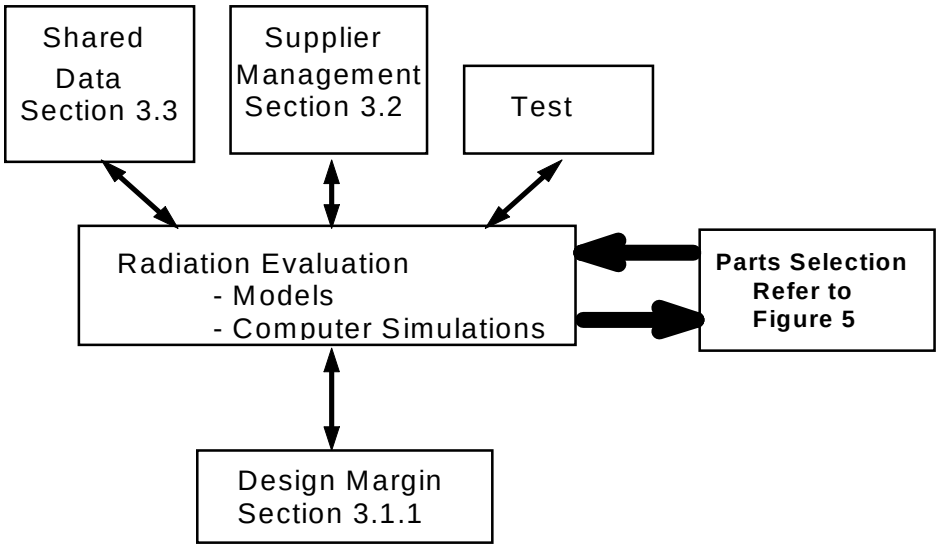
Integrated Circuits require more attention during the selection process than most semiconductor devices. Table III shows the types of technologies of Integrated Circuits that are typically sensitive (S) , tolerant (T), or uses a process that improves radiation tolerance for each environmental effects. The sensitive technologies can be used, but will depend on circuit as well as system application. There are literature, handbooks and databases available in the industry that can help in the selection process.

Table III - Risk of Integrated Circuit Technology to Radiation Effects (Use as a guide, only)

	Environmental Effects				
Integrated Circuit Technology	Total Dose	Displacement Damage	Dose Rate	SEU	SEL
Bipolar Digital	T	S	T	S	T
Bipolar Linear	S	S	T	S	T
ECL	T	T	T	S	T
MOS (includes CMOS, PMOS, etc.)	S	T	S	T	S
BiMOS/BiCMOS	S	S	S	S	S
GaAs	T	T	S	S	S
New Technologies (e.g., Low Voltage Technologies)	TBD	TBD	TBD	TBD	TBD
Epitaxial process	N/A	N/A	E	E	E
DI Process	N/A	N/A	E	E	E
SOI Process	E	N/A	E	E	E
SOS Process	E	N/A	E	E	E
Neutron Enhancement	N/A	N/A	E	E	E

Technical Support

Successful implementation of analysis will require radiation data from various sources, design information and test data as necessary. The sources to obtain radiation information can be derived from the common database and supplier management information. Design information required can be obtained from the design engineer.



Technology Insertion

Any new technology used in a radiation environment should be assessed for its radiation hardness capability. Some ways to assess the radiation hardness are:

- Parts Selection Process (Section 3.1.5)
- Testing
- Analysis
- Supplier Management (Section 3.2), e.g., developing a supplier to develop the capability of producing a radiation hardened part, or asking the supplier for available radiation data.

Life Cycle Cost

The semiconductor technologies are moving, e.g., from higher operating voltages (currently 5V) to lower operating voltages. This evolution, coupled with future changes in the design or technology of the part, made by the supplier, could have considerable impact on the radiation characteristics of the part which could compromise its capability to meet circuit requirements. This could have considerable cost impact over the Life Cycle of the hardware. Other changes include die topology.

Validation

Radiation performance can be validated in the following ways:

- Testing
- Analysis

Traceability of radiation performance can be done in the following ways

- Engineering documentation
- Engineering notebooks
- Production control documentation
- Process control documentation
- Databases

Attachment 1 Subcontractor Assessment

1.0 PROCESS CONTROLS

1.1 QUALITY MANAGEMENT PLAN

1.1.1 Does the subcontractor have a quality management plan?
Yes_____ No_____ N/A_____

1.1.2 Does the subcontractor have support and involvement of management in implementing and maintaining the quality management plan?
Yes_____ No_____ N/A_____

1.1.3 Does the subcontractor have a documented and implemented plan to select "world class" suppliers?
Yes_____ No_____ N/A_____

1.1.4 Does the subcontractor review the supplier's quality management plan?
Yes_____ No_____ N/A_____

1.1.5 Does the subcontractor verify that the supplier's quality management plan has the support and involvement of the supplier's management in implementing and maintaining the plan?
Yes_____ No_____ N/A_____

1.1.6 Does the subcontractor verify that communication exists at the supplier between design, fabrication, test and field regarding performance, quality, reliability, and failure analysis using statistical techniques?
Yes_____ No_____ N/A_____

1.1.7 Does the subcontractor determine if the supplier's quality management plan charters an internal control board or procedure that maintains communication between groups, evaluates data (SPC, reliability, screening, failure analysis, etc.), determines corrective action, and maintains records?
Yes_____ No_____ N/A_____

1.1.8 Does the subcontractor have the name of a key contact in the internal control board?
Yes_____ No_____ N/A_____

1.1.9 Does the subcontractor verify that the supplier's quality plan establishes clear lines of authority and responsibility?
Yes_____ No_____ N/A_____

1.1.10 Does the subcontractor verify that the supplier's quality plan provides for periodic internal audits?
Yes_____ No_____ N/A_____

1.1.11 Does the subcontractor review the supplier's quality documentation procedures?
Yes_____ No_____ N/A_____

1.1.12 Does the subcontractor determine if the supplier has completed a self-assessment of their quality management plan using the questions for the Malcolm Baldridge Quality Award or other similar evaluations?
Yes_____ No_____ N/A_____

1.1.13 Does the subcontractor evaluate the supplier's self-assessment?
Yes_____ No_____ N/A_____

1.1.14 Does the subcontractor determine if the supplier is certified for ISO-9000?
Yes_____ No_____ N/A_____

1.1.15 Does the subcontractor evaluate the supplier's preventive maintenance procedure?
Yes_____ No_____ N/A_____

1.2 STATISTICAL PROCESS CONTROL (SPC)

1.2.1 Does the subcontractor select suppliers with wafer fabrication and assembly lines in continuous, high volume production?
Yes_____ No_____ N/A_____

1.2.2 Does the subcontractor determine if the supplier has documented and implemented a plan of SPC for wafer and assembly process steps?
Yes_____ No_____ N/A_____

1.2.3 Does the subcontractor evaluate the supplier's SPC to determine if sufficient control exists for at least the following wafer fabrication steps:
Yes_____ No_____ N/A_____

Wafer
EPI layers
Wafer backside preparation
Masks
Photolithography
Diffusion
Ion implantation
Annealing
Oxide deposition/growth
Nitride deposition
Poly deposition
Metal deposition
Dielectric etch
Poly etch
Metal etch
Rework
Wafer parametric data
Lot acceptance results
Reliability test results

1.2.4 Does the subcontractor evaluate the supplier's SPC to determine if sufficient control exists for at least the following assembly steps:
Yes_____ No_____ N/A_____

Materials
Thick film deposition
Wafer mount
Wafer saw
Visual
Die attach
Wirebond
Die encapsulation
Visual
Molding compound process (PEM)
Lid attach (hermetic)
Lead trim and form
Lead finish
Hermiticity (hermetic)
Internal water vapor (hermetic)
Electrical test
Mark
Dimensions

1.2.5 Does the subcontractor's supplier evaluation criteria recognize the effectiveness of paperless manufacturing lines with computer aided manufacturing (CAM) systems?
Yes_____ No_____ N/A_____

1.2.6 Does the subcontractor's supplier evaluation criteria recognize the effectiveness of computer automated SPC chart generation?
Yes_____ No_____ N/A_____

1.2.7 Does the subcontractor request copies of current SPC control charts?
Yes_____ No_____ N/A_____

1.2.8 Does the subcontractor review the supplier's documented SPC goals and metrics?
Yes_____ No_____ N/A_____

1.2.9 Does the subcontractor review the supplier's periodic progress reports on SPC goals?
Yes_____ No_____ N/A_____

1.2.10 Does the subcontractor review the supplier's procedures for determining target values at critical process nodes?
Yes_____ No_____ N/A_____

1.2.11 Does the subcontractor review the supplier's procedures for responding to deficiencies?
Yes_____ No_____ N/A_____

1.3 CONTINUOUS IMPROVEMENT

1.3.1 Does the subcontractor verify that the supplier has a documented and implemented plan for continuous improvement?
Yes_____ No_____ N/A_____

1.3.2 Does the subcontractor verify that a continuous improvement feedback loop exists from test and field operations to design and fabrication regarding yield, performance and reliability?
Yes_____ No_____ N/A_____

1.3.3 Does the subcontractor review the supplier's process/product improvement projects?
Yes_____ No_____ N/A_____

1.3.4 Does the subcontractor review process/product improvement metrics?
Yes_____ No_____ N/A_____

1.3.5 Does the subcontractor request data on specific process/product improvements and the resulting feedback from field data?
Yes_____ No_____ N/A_____

1.3.6 Does the subcontractor's supplier evaluation criteria recognize the effectiveness design of experiments (DOE)?
Yes_____ No_____ N/A_____

1.3.7 Does the subcontractor have expertise to review and evaluate the supplier's use of wafer fabrication and assembly yield models (such as Moore, Murphy, Poisson, Seeds, or supplier developed)?
Yes_____ No_____ N/A_____

1.4 NEW PRODUCT DEVELOPMENT

1.4.1 Does the subcontractor review the supplier's concurrent engineering teams that are used to develop new parts?
Yes_____ No_____ N/A_____

1.4.2 Does the subcontractor review the supplier's use of proven design rules and standard cells that incorporate process variation statistics?

Yes_____ No_____ N/A_____

1.4.3 Does the subcontractor review the supplier's methodology of incorporating reliability data from testing, production and field into design rules or standard cells?

Yes_____ No_____ N/A_____

1.4.4 Does the subcontractor determine if it is supplier policy to qualify all new parts through reliability testing?

Yes_____ No_____ N/A_____

1.4.5 Does the subcontractor have an acceptable procedure to qualify industrial grade ceramic parts? In particular, regarding the following:

Yes_____ No_____ N/A_____

Does supplier produce equivalent MIL part?
Is industrial grade part fabricated on same wafer fabrication line as MIL part?
Is industrial grade part assembled on same line as MIL part?
Verify that industrial grade part is not a downgraded MIL part.
Pre-cap visual performed on 100% parts?
Fine and gross leak performed on 100% parts?
Final electrical tests performed at -40¡C, room temp, and +85¡C or better?
High temperature operating life
Thermal shock
Temperature cycling
Vibration
Acceleration
ESD sensitivity
Solvent resistance
Bond strength
Die shear
Solderability
Lead integrity
Salt atmosphere
External visual on 100% parts?

1.4.6 Does the subcontractor have an acceptable procedure to qualify plastic encapsulated parts? In particular, regarding the following:

Yes_____ No_____ N/A_____

Electrical test at min., room, and max. temps.
Preconditioning procedures
High temperature operating life
Thermal cycling
Bond pull
Ball shear
Die shear
Highly accelerated stress (HAST)
Autoclave
ESD sensitivity
Solderability
Salt atmosphere
Lead integrity

1.5 QUALITY CONTROL

1.5.1 Does the subcontractor have an acceptable procedure to screen hermetic ceramic parts? In particular, regarding:

Yes_____ No_____ N/A_____

Pre burn-in electrical
Burn-in
Final electrical
External visual

1.5.2 Does the subcontractor have an acceptable procedure to screen plastic encapsulated parts? In particular, regarding:

Yes_____ No_____ N/A_____

Pre burn-in electrical
Preconditioning
Burn-in
Final electrical
External visual

1.5.3 If the subcontractor allows the deletion a qualification or screening step listed above, does subcontractor have sufficient test data to justify omitting the step?

Yes_____ No_____ N/A_____

1.5.4 Does the subcontractor obtain copies of the supplier qualification test data for new parts?

Yes_____ No_____ N/A_____

1.5.5 Does the subcontractor re-qualify a part when processes or materials are changed?

Yes_____ No_____ N/A_____

1.5.6 Does the subcontractor have sufficient expertise to review and evaluate the supplier's failure analysis on failed parts to determine the physics of failure?

Yes_____ No_____ N/A_____

1.5.7 Does the subcontractor review the supplier's corrective action plan to correct defects or out of control processes?

Yes_____ No_____ N/A_____

1.5.8 Does the subcontractor review the supplier's change control program for designs, processes, and materials?

Yes_____ No_____ N/A_____

1.5.9 Does the subcontractor receive notification when any changes to designs, processes or materials occur?

Yes_____ No_____ N/A_____

1.5.10 Does the subcontractor receive notification when problems with parts are identified and subsequently resolved?

Yes_____ No_____ N/A_____

1.5.11 Does the subcontractor require the supplier to have a quality monitoring program that periodically performs reliability tests on samples taken from the production lines?

Yes_____ No_____ N/A_____

1.5.12 Does the subcontractor receive copies of the periodic quality monitor reports?

Yes_____ No_____ N/A_____

1.5.13 Does subcontractor use industry standard packages?

Yes_____ No_____ N/A_____

1.5.14 Does the subcontractor review GIDEP alerts and responses on the supplier's parts or processes?

Yes_____ No_____ N/A_____

1.5.15 Does the subcontractor have a list of recommended non-MIL replacement parts?

Yes_____ No_____ N/A_____

1.5.16 Does the subcontractor perform additional testing when a replacement part is used?

Yes_____ No_____ N/A_____

2.0 **PART QUALIFICATION**

2.1 SELECTION CRITERIA

2.1.1 Did the subcontractor follow the supplier selection criteria described the subcontractor's parts management plan?

Yes_____ No_____ N/A_____

2.1.2 Did the subcontractor follow the part selection criteria described the subcontractor's parts management plan?

Yes_____ No_____ N/A_____

2.1.3 Does the subcontractor's evaluation of part qualification and screening data follow the documented procedures in the subcontractor's parts management plan?

Yes_____ No_____ N/A_____

2.1.4 Does the subcontractor have sufficient data to assure that the subsystem will meet all electrical performance requirements using the selected parts?

Yes_____ No_____ N/A_____

2.1.5 Does the subcontractor have sufficient data to assure that the subsystem will meet all thermal requirements using the selected parts?

Yes_____ No_____ N/A_____

2.1.6 Does the subcontractor have sufficient data to assure that the subsystem will meet all mechanical requirements using the selected parts?

Yes_____ No_____ N/A_____

2.1.7 Does the subcontractor have sufficient data to assure that the subsystem will meet all reliability requirements using the selected parts?

Yes_____ No_____ N/A_____

2.1.8 Does the subcontractor have sufficient data to assure that the subsystem has acceptable compatibility of materials and processes using the selected parts?

Yes_____ No_____ N/A_____

2.1.9 Does the next level assembly require performance of the part that is near the specification limits or is there sufficient margin?

Yes_____ No_____ N/A_____

2.1.10 Are there multiple sources for the part?

Yes_____ No_____ N/A_____

2.1.11 Does the subcontractor provide adequate assurance that the part will be available for both the short and long term? If not, is there an acceptable obsolescence plan?

Yes_____ No_____ N/A_____

Attachment 2 EEE Parts - Supplier Assessment

1.0 **PROCESS CONTROLS**

1.1 QUALITY MANAGEMENT PLAN

1.1.1 Does the supplier have a documented and implemented quality management plan?
Yes_____ No_____ N/A_____

1.1.2 Does the supplier have support and involvement of management in implementing and maintaining the quality management plan?
Yes_____ No_____ N/A_____

1.1.3 Does the quality management plan require communication between design, fabrication, test and field regarding performance, quality, reliability, and failure analysis using statistical techniques?
Yes_____ No_____ N/A_____

1.1.4 Does the quality management plan charter an internal control board (i.e.,. similar to a technical review board) that maintains communication between groups, evaluates data (SPC, reliability, screening, failure analysis, etc.), determines corrective action, and maintains records?
Yes_____ No_____ N/A_____

1.1.5 Will the supplier supply the name of a key contact in the internal control board?
Yes_____ No_____ N/A_____

1.1.6 Does the quality plan establish clear lines of authority and responsibility?
Yes_____ No_____ N/A_____

1.1.7 Does the quality plan provide for periodic internal audits?
Yes_____ No_____ N/A_____

1.1.8 Does the quality plan require documentation of audits and follow-up actions?
Yes_____ No_____ N/A_____

1.1.7 Has the supplier completed a self-assessment of their quality management plan using the questions for the Malcolm Baldridge Quality Award or other similar evaluations?
Yes_____ No_____ N/A_____

1.1.8 Are the results of the self-assessment of the quality management plan available for review?
Yes_____ No_____ N/A_____

1.1.9 Is the supplier certified for ISO-9000?
Yes_____ No_____ N/A_____

1.1.10 Does supplier have an effective preventive maintenance procedure?
Yes_____ No_____ N/A_____

1.2 STATISTICAL PROCESS CONTROL (SPC)

1.2.1 Are the supplier's wafer fabrication and assembly lines in continuous, high volume production?
Yes_____ No_____ N/A_____

1.2.2 Has the supplier documented and implemented a plan of SPC for wafer and assembly process steps?
Yes_____ No_____ N/A_____

1.2.3 Does the supplier have sufficient SPC control for at least the following wafer fabrication steps:

Yes_____ No_____ N/A_____

Wafer
EPI layers
Wafer backside preparation
Masks
Photolithography
Diffusion
Ion implantation
Annealing
Oxide deposition/growth
Nitride deposition
Poly deposition
Metal deposition
Dielectric etch
Poly etch
Metal etch
Rework
Wafer parametric data
Lot acceptance results
Reliability test results

1.2.4 Does the supplier have sufficient SPC control for at least the following assembly steps:

Yes_____ No_____ N/A_____

Materials
Thick film deposition
Wafer mount
Wafer saw
Visual
Die attach
Wirebond
Die encapsulation
Visual
Molding compound process (PEM)
Lid attach (hermetic)
Lead trim and form
Lead finish
Hermiticity (hermetic)
Internal water vapor (hermetic)
Electrical test
Mark
Dimensions

1.2.5 Does the supplier have a paperless manufacturing line with a computer aided manufacturing (CAM) system?

Yes_____ No_____ N/A_____

1.2.6 Does the supplier use computer automated SPC chart generation instead of manually plotted SPC charts?

Yes_____ No_____ N/A_____

1.2.7 Is the supplier willing to provide copies of current SPC control charts?

Yes_____ No_____ N/A_____

1.2.8 Does the supplier have documented SPC goals with metrics?

Yes_____ No_____ N/A_____

1.2.9 Does the supplier have periodic progress reports on SPC goals?

Yes_____ No_____ N/A_____

1.2.10 Does the supplier have documented procedures for determining target values at critical process nodes?

Yes_____ No_____ N/A_____

1.2.11 Does the supplier have a documented procedure for responding to deficiencies?

Yes_____ No_____ N/A_____

1.3 CONTINUOUS IMPROVEMENT

1.3.1 Does supplier have a documented and implemented plan for continuous improvement?

Yes_____ No_____ N/A_____

1.3.2 Does a continuous improvement feedback loop exist from test and field operations to design and fabrication regarding yield, performance and reliability?

Yes_____ No_____ N/A_____

1.3.3 Has the supplier identified specific process/product improvement projects?

Yes_____ No_____ N/A_____

1.3.4 Does the supplier have process/product improvement metrics that show appropriate improvements over time?

Yes_____ No_____ N/A_____

1.3.5 Is supplier willing to provide data on specific process/product improvements and the resulting feedback from field data?

Yes_____ No_____ N/A_____

1.3.6 Does supplier utilize design of experiments (DOE)?

Yes_____ No_____ N/A_____

1.3.7 Does the supplier use a wafer fabrication and assembly yield model developed specifically for their processes instead of a standard model (such as Moore, Murphy, Poisson, Seeds, etc.)?

Yes_____ No_____ N/A_____

1.4 NEW PRODUCT DEVELOPMENT

1.4.1 Does supplier utilize concurrent engineering teams when developing new parts?

Yes_____ No_____ N/A_____

1.4.2 Does the supplier use proven design rules and standard cells that incorporate process variation statistics?

Yes_____ No_____ N/A_____

1.4.3 Does supplier incorporate reliability data from testing, production and field into design rules or standard cells?

Yes_____ No_____ N/A_____

1.4.4 Is it supplier policy to qualify all new parts through reliability testing?

Yes_____ No_____ N/A_____

1.4.5 How does supplier qualify industrial grade ceramic parts? In particular, regarding the following:
- Does supplier produce equivalent MIL part?
- Is industrial grade part fabricated on same wafer fabrication line as MIL part?
- Is industrial grade part assembled on same line as MIL part?
- Verify that industrial grade part is not a downgraded MIL part.
- Pre-cap visual performed on 100% parts?
- Fine and gross leak performed on 100% parts?
- Final electrical tests performed at -40¡C, room temp, and +85¡C or better?
- High temperature operating life
- Thermal shock
- Temperature cycling
- Vibration
- Acceleration
- ESD sensitivity
- Solvent resistance
- Bond strength
- Die shear
- Solderability
- Lead integrity
- Salt atmosphere
- External visual on 100% parts?

1.4.6 How does supplier qualify plastic encapsulated parts? In particular, regarding the following:
- Electrical test at min., room, and max. temps.
- Preconditioning procedures
- High temperature operating life
- Thermal cycling
- Bond pull
- Ball shear
- Die shear
- Highly accelerated stress (HAST)
- Autoclave
- ESD sensitivity
- Solderability
- Salt atmosphere
- Lead integrity

1.5 QUALITY CONTROL

1.5.1 How does supplier screen hermetic ceramic parts? In particular, regarding:
- Pre burn-in electrical
- Burn-in
- Final electrical
- External visual

1.5.2 How does supplier screen plastic encapsulated parts? In particular, regarding:
- Pre burn-in electrical
- Preconditioning
- Burn-in
- Final electrical
- External visual

1.5.3 If supplier does not or will not perform a qualification or screening step listed above, does supplier have sufficient test data to justify omitting the step?

Yes_____ No_____ N/A_____

1.5.4 Is supplier willing to provide qualification test data for new parts?

Yes_____ No_____ N/A_____

1.5.5 Is it supplier policy to re-qualify a part when processes or materials are changed?

Yes_____ No_____ N/A_____

1.5.6 Does supplier perform failure analysis on failed parts to determine the physics of failure?
Yes_____ No_____ N/A_____

1.5.7 Does supplier have a corrective action plan to correct defects or out of control processes?
Yes_____ No_____ N/A_____

1.5.8 Does supplier have a change control program for designs, processes, and materials?
Yes_____ No_____ N/A_____

1.5.9 Is supplier willing to notify customers when any changes to designs, processes or materials occur?
Yes_____ No_____ N/A_____

1.5.10 Is supplier willing to notify customers when problems with parts are identified and subsequently resolved?
Yes_____ No_____ N/A_____

1.5.11 Does supplier have a quality monitoring program that periodically performs reliability tests on samples taken from the production lines?
Yes_____ No_____ N/A_____

1.5.12 Are copies of the periodic quality monitor reports available?
Yes_____ No_____ N/A_____

1.5.13 Does supplier use industry standard packages?
Yes_____ No_____ N/A_____

1.5.14 Does supplier have excessive GIDEP alerts on their parts or processes? Are responses to alerts acceptable?
Yes_____ No_____ N/A_____

1.5.15 Does the supplier (or subcontractor) have a list of recommended non-MIL replacement parts?
Yes_____ No_____ N/A_____

1.5.16 Does the supplier recommend additional testing when a replacement part is used?
Yes_____ No_____ N/A_____

2.0 PART QUALIFICATION

2.1 DESIGN

2.1.1 Were proven design rules or standard cells used for the design of the part?
Yes_____ No_____ N/A_____

2.1.2 Was reliability data from testing, production and field incorporated into the design rules or standard cells for this part?
Yes_____ No_____ N/A_____

2.1.3 Did the supplier exercise sufficient design control, verification, prototyping and qualification for the part?
Yes_____ No_____ N/A_____

2.1.4 Did the supplier include the full operating temperature range in the part design?
Yes_____ No_____ N/A_____

2.1.5 Has material compatibility been addressed in part design? In particular, regarding dissimilar metals used in wire bonding? Yes_____ No_____ N/A_____

2.1.6 Are cleaning materials compatible with part materials, both internal and external? In particular, will cleaning materials corrode part materials? Have long term effects been considered?
Yes_____ No_____ N/A_____

2.1.7 Were coefficients of thermal expansion considered when designing and processing parts?
Yes_____ No_____ N/A_____

2.1.8 Are there any potential areas where part reliability may be effected during environmental stress testing due to mismatches in coefficients of thermal expansion?
Yes_____ No_____ N/A_____

2.1.9 Does the next level assembly require performance of the part that is near the specification limits or is there sufficient margin?
Yes_____ No_____ N/A_____

2.2 MANUFACTURING

2.2.1 Is the part a high volume, continuous production, catalog part?
Yes_____ No_____ N/A_____

2.2.2 Does the supplier use statistical techniques to establish, control and verify fabrication processes and performance characteristics?
Yes_____ No_____ N/A_____

2.2.3 Are the processes and equipment used to fabricate the part common to a family of parts?
Yes_____ No_____ N/A_____

2.2.4 Are there multiple sources for the part?
Yes_____ No_____ N/A_____

2.2.5 Does the supplier provide adequate assurance that the part will be available for both the short and long term? If not, is there an acceptable obsolescence plan?
Yes_____ No_____ N/A_____

2.2.6 Does supplier have documented procedures to inspect and control materials used to fabricate the part?
Yes_____ No_____ N/A_____

2.2.7 Does supplier have documented process instructions, lot travelers, and SPC control points for wafer fabrication? In particular, is there sufficient control for at least the following steps:
Yes_____ No_____ N/A_____

Wafer
EPI layers
Wafer backside preparation
Masks
Photolithography
Diffusion
Ion implantation
Annealing
Oxide deposition/growth
Nitride deposition
Poly deposition
Metal deposition
Dielectric etch
Poly etch
Metal etch
Rework
Wafer parametric data
Lot acceptance results
Reliability test results

2.2.8 Does supplier have documented process instructions, lot travelers, and SPC control points for hermetic part assembly? In particular, is there sufficient control for at least the following steps:

Yes_____ No_____ N/A_____

Wafer mount
Wafer saw
Visual
Material composition
Die attach
Wirebond
Die encapsulation
Visual
Lid attach
Lead trim and form
Lead finish
Electrical test
Hermiticity
Internal water vapor
Mark
Dimensions

2.2.9 Does supplier have documented process instructions, lot travelers, and SPC control points for molded part assembly? In particular, is there sufficient control for at least the following steps:

Yes_____ No_____ N/A_____

Wafer mount
Wafer saw
Visual
Leadframe composition
Die attach
Wirebond
Visual
Epoxy molding compound composition
Molding process parameters
Postmold cure
Deflash
Lead trim and form
Lead finish
Electrical test
Mark
Dimensions

2.3 TEST

2.3.1 How does supplier qualify part if it is industrial grade hermetic ceramic? In particular, regarding the following:

- Does supplier produce equivalent MIL part?
- Is industrial grade part fabricated on same wafer fabrication line as MIL part?
- Is industrial grade part assembled on same line as MIL part?
- Verify that industrial grade part is not a downgraded MIL part.
- Pre-cap visual performed on 100% parts?
- Fine and gross leak performed on 100% parts?
- Final electrical tests performed at -40¡C, room temp, and +85¡C or better?
- High temperature operating life
- Thermal shock
- Temperature cycling
- Vibration
- Acceleration
- ESD sensitivity
- Solvent resistance
- Bond strength
- Die shear
- Solderability
- Lead integrity
- Salt atmosphere
- External visual on 100% parts?

2.3.2 How does supplier qualify part if it is plastic encapsulated? In particular, regarding the following:

- Electrical test at min., room, and max. temps.
- Preconditioning procedures
- High temperature operating life
- Thermal cycling
- Bond pull
- Ball shear
- Die shear
- Highly accelerated stress (HAST)
- Autoclave
- ESD sensitivity
- Solderability
- Salt atmosphere
- Lead integrity

2.3.3 How does supplier screen part if it is hermetic ceramic? In particular, regarding:

- Pre burn-in electrical at -55¡C, room temp, +125¡C
- Burn-in
- Final electrical at -55¡C, room temp, +125¡C
- External visual

2.3.4 How does supplier screen part if it is plastic encapsulated? In particular, regarding:

- Pre burn-in electrical at min., room, and max. temps on 100%
- Preconditioning
- Burn-in
- Final electrical
- External visual

2.3.5 If supplier omits a qualification or screening step listed above, does supplier have sufficient test data to justify omitting the step?

Yes_____ No_____ N/A_____

2.3.6 Does the supplier have internal test specifications that adequately test the performance characteristics of the part?

Yes_____ No_____ N/A_____

2.3.7 Does the supplier have sufficient control in place to assure that no parts are shipped until all specified tests are complete?

Yes_____ No_____ N/A_____

2.3.8 Are tests systems and software of sufficient accuracy and precision to perform the specified tests?

Yes_____ No_____ N/A_____

2.3.9 Does supplier have sufficient maintenance, calibration and repair procedures to maintain the required accuracy and precision of the test systems?

Yes_____ No_____ N/A_____

2.4 RELIABILITY

2.4.1 Does the reliability of the part meet program requirements?

Yes_____ No_____ N/A_____

2.4.2 Does supplier have sufficient data, both accelerated test data and field data, to support the reliability claims?

Yes_____ No_____ N/A_____

2.4.3 Does supplier correlate accelerated test data with field failure data?

Yes_____ No_____ N/A_____

2.4.4 Does the supplier destructively analyze failed parts to determine the failure mechanism?

Yes_____ No_____ N/A_____

2.4.5 Does supplier have a good understanding of the physics of failure for each of the failure mechanisms in the part?

Yes_____ No_____ N/A_____

2.4.6 Does the supplier have a sufficient enough understanding of the physics and the statistical methods of accelerated reliability tests to determine realistic failure rates in the mission environment?

Yes_____ No_____ N/A_____

2.4.7 Does the supplier have data on long term dormant storage of the part?

Yes_____ No_____ N/A_____

2.4.8 Does the supplier have data on infant mortality rates for the part?

Yes_____ No_____ N/A_____

2.4.9 Do the projected infant mortality rates meet program requirements?

Yes_____ No_____ N/A_____

2.4.10 For plastic encapsulated parts, do the HAST tests show the equivalent of zero failures out of 30 parts at 85¡C/85%RH for 10,000 hours using the Pecht model?

Yes_____ No_____ N/A_____

2.4.11 Does the supplier have sufficient data on the thermal characteristics of the part (for example, thermal modeling of hot spots on the chip)?

Yes_____ No_____ N/A_____

2.4.12 If pyroshock is an issue for the mission environment, does the supplier have data on the sensitivity of the part to pyroshock?

Yes_____ No_____ N/A_____

3.0 HANDLING, SHIPPING AND PWB ASSEMBLY

3.1 HANDLING

3.1.1 Are the supplier's handling procedures and storage areas sufficient to prevent damage or deterioration of the part?

Yes_____ No_____ N/A_____

3.1.2 What is the moisture sensitivity level of the part (JESD22-A112)?

Value_____ N/A_____

3.1.3 Does the supplier have recommended procedures for storing and handling of the part to avoid moisture-induced stress during solder re-flow?

Yes_____ No_____ N/A_____

3.1.4 Do supplier's part handling procedures and areas prevent damage or deterioration to the part?

Yes_____ No_____ N/A_____

3.1.5 Does supplier have an inventory management system to rotate stock or periodically check parts in stock for deterioration?

Yes_____ No_____ N/A_____

3.2 SHIPPING

3.2.1 Are parts shipped in containers to prevent moisture absorption and ESD damage?

Yes_____ No_____ N/A_____

3.2.2 If parts are moisture sensitive, are parts shipped with a moisture indicator?

Yes_____ No_____ N/A_____

3.2.3 Are parts shipped directly from the supplier or through a distributor?

Supplier_____Distrib._____

3.2.4 If parts are from a distributor, are the distributor's handling and storage procedures sufficient to prevent damage or deterioration to the part?

Yes_____ No_____ N/A_____

3.2.5 Does distributor split shipments and re-bag parts? Are procedures sufficient to prevent damage or deterioration to the part?

Yes_____ No_____ N/A_____

3.2.6 Does distributor maintain a traceability path for the parts?

Yes_____ No_____ N/A_____

3.2.7 Does distributor have an inventory management system to rotate stock or periodically check parts in stock for deterioration?

Yes_____ No_____ N/A_____

3.3 PWB ASSEMBLY

3.3.1 Does the supplier have a range of recommended process conditions for re-flow solder?

Yes_____ No_____ N/A_____

3.3.2 Does the supplier recommend preconditioning of the part prior to re-flow soldering?

Yes_____ No_____ N/A_____

3.3.3 Does the part have a maximum tolerable exposure time to air prior to re-flow solder?

Yes_____ No_____ N/A_____

3.3.4 Are the supplier recommended SMT and Through-Hole PWB assembly procedures compatible with standard processes? Yes_____ No_____ N/A_____

Attachment 3 Mechanical Parts - Supplier Assessment

1.0. GENERAL MECHANICAL SURVEY

1.1 Pre-Visit Evaluation considerations

1.1.1 Any GIDEP Alerts within the last 3 years? If yes, was supplier response and corrective action adequate?
1.1.2 Any failure analysis within the last 5 years, If yes, was supplier response and corrective action adequate?
1.1.3 Product Assurance: Describe past performance rate (reject rate)
1.1.4 Inform supplier of expectations.

1.2 Facilities

1.2.1. Are testing areas climate controlled?
1.2.2 Are there any outstanding legal issues with the EPA?
1.2.3 General facility appearance/cleanliness.

1.3 Capabilities

1.3.1 Is all the product procured and manufactured in the USA? If not, explain.
1.3.2 Is there a formal material
1.3.3 List processes, plants, and subcontractors involved with this product: (failure analysis, lab analysis, etc.)
1.3.4 What controls are imposed on subcontracted items? Certified/Qualified Periodically surveyed, source inspected, etc.

1.4 Quality Management Plan

1.4.1 Does the supplier have a documented and implemented quality management plan?
1.4.2 Does the supplier have support and involvement of management in implementing and maintaining the quality management plan?
1.4.3 Does the quality management plan require communication between design, fabrication, test and field regarding performance, quality reliability, and failure analysis?
1.4.4 Does the quality management plan charter an internal control board (i.e. similar to a technical review board) that maintains communication between groups, evaluates data(SPC, reliability, screening, failure analysis, etc.) determines corrective action, and maintains records?
1.4.5 Will the supplier supply the name of the key contact in the internal control board?
1.4.6 Does the quality plan establish clear lines of authority and responsibility?
1.4.7. Does the quality plan provide for periodic internal audits?
1.4.8 Does the quality plan require documentation of audits and follow-up actions?
1.4.9 Has the supplier completed a self-assessment of their quality management plan using the questions for the Malcolm Baldridge Quality Award or other similar evaluations?
1.4.10 Are the results of the self-assessment of the quality management plan available for review?
1.4.11. Is the supplier certified for ISO-9000?
1.4.12. Does supplier have an effective preventative maintenance procedure?

1.5 Statistical Process Control

1.5.1. Are the supplier’s lines in continuous high volume production?
1.5.2 Does the supplier have a documented SPC plan with goals and metrics? Is it effectively implemented?

1.6 Other Considerations

1.6.1 Are there failure analysis capabilities and if so, where?
1.6.2 Are parts reworked?
1.6.3 Is there a calibration program?
1.6.4 What laboratory analysis is available? (Destructive and non-destructive facilities)
1.6.5 Does the supplier have sufficient procedures documented for in-process and final testing.
1.6.6 Are any inspections performed on 100% of parts?

1.7 Quality Assurance

1.7.1 Is supplier willing to provide qualification test data for new parts?
1.7.2 Is it supplier policy to re-qualify a part when processes or materials are changed?
1.7.3 Does Supplier perform failure analysis on failed parts to determine the physics of failure?
1.7.4 Does supplier have a corrective action plan to correct defects or out of control processes?
1.7.5 Does supplier have a change control program for designs, processes or materials?
1.7.6 Is supplier willing to notify customers when any changes to designs, processes or materials occur?
1.7.7 Is supplier willing to notify customers when problems with parts are identified and
1.7.8 subsequently resolved?
1.7.8 Are copies of the periodic quality monitor reports available?

2.0 Heat Transfer Checklist

2.1 Are specifications available, understood, and followed?
2.2 Are written processing and process solution control procedures adequate and implemented?
2.3 Is temperature control equipment of the automatic controlling recording potentiometic type?
2.4 Are furnaces equipped with temperature over-ride controls?
2.5 Are pyrometers balance checked prior to each day's use?
2.6 Are pyrometers checked weekly for accuracy? How?
2.7 Are the control couples in the working areas of the furnace protected from the furnace atmosphere?
2.8 Are temperature uniformity surveys conducted?
2.9 Are metallurgical and physical evaluations performed concurrent with the temperature uniformity surveys of equipment used for the heat treatment of steel?
2.10 Are furnaces temperatures and salt baths controlled to prevent material surface deterioration?
2.11 Are furnace temperature spot checked with a test thermocouple periodically?
2.12 Are parts adequately separated and supported during heating and quenching?
2.13 Are quench delay times maintained within the maximum limits? (i.e. are they specified and adhered to?
2.14 Are correct quench bathe temperatures maintained?
2.15 Are small parts quenched by dumping?
2.16 Are the number of re-heat treatments restricted in accordance with the applicable specifications?
2.17 Hoe are corrosion, decarburization, carburization, and intergranular corrosion prevented?
2.18 What time frame between quenching and tempering? 2 hrs. max.
2.19 How do you clean steel so as to not introduce hydrogen?
2.20 Are hardness samples & test data for hardness maintained?
2.21 How to hold the 20 kpsi max. above the minimum & records? (i.e. 160 to 180 kpsi)
2.22 Is all file data available for 5 years?
2.23 Are coupons processed and evaluated with each lot?
2.23.1 Each lot for 220kpsi?
2.23.2 Each mo. for atmospheric furnaces?
2.23.3 Each week for salt baths?
2.24 Is ductility testing performed?

3.0 Plater Survey

3.1 Determine if there are records showing that the following are maintained:

3.1.1 How is it determined which plating process is applicable to the alloy involved?
3.1.2 Stress relief: Are 159kpsi (Rhc34) and above parts which have been machined, ground cold formed, cold straightened, etc. after heat treatment, stress relieve baked at 375+/- 25 deg. F for a minimum of 4 hours prior to cleaning and plating? Exception: Fasteners with cold work heed to shank fillet radius or thread rolled after heat treatment.
3.1.3 Are appropriate & controlled processes used for cleaning prior to plating? Abrasive cleaning for removal of heating treatment scale and oxidation or alkaline cleaning whit anodic or no current are allowable. Picking is not recommended.
3.1.4 What is the process to assure complete coverage, including roots of threads, corners, and recesses?
3.1.5 Use of brightening agents on plated parts 150kpsi (Rhc34) and higher is not recommended.
3.1.6 Supplementary Chromate Treatment:
3.1.6.1 Unless otherwise stated, is type II plating applied and after baking?
3.1.6.1 Is the chromate treatment for conversion to type II an aqueous solution of salts, acids, or both (Note: Usual chromic and nitric acid bright dips for cadmium are not chromate treatments)?
3.1.7 Reactivate after baking & before chromate treatment within time limits?
3.1.8 Environmental Requirements: Does the supplier comply with EPA, Federal, State, and Local government guidelines?
3.1.9. Process Control: Is there one year history of the processing baths, showing all additions of chemical or treatment solutions and the results of all chemical analysis performed?
3.1.9.1 Filtration performed_____ Weeks/Months by:
3.1.9.2 How is plate stripping performed?
3.1.10 Lot definition: A lot consists of plating articles of the same basis metals composition, class and type plated and treated under the same conditions and submitted for inspection at one time.
3.1.11 Sampling procedures and results.
3.1.12 Production control testing: Adhesion, Corrosion Resistance, and Hydrogen Embrittlement. Do records indicate when lot tests are substituted for production control tests?
3.1.13 Are quality conformance test performed on each lot? (If not, what is the frequency). Are these tests performed on specimens made from equivalent base metals, plated concurrently with the parts?
3.1.14 Hydrogen Embrittlement Relief:
3.1.14.1 Are 150kpsi (Rhc34) and higher parts baked after plating at 375+/-25 deg. F minimum, within 4 hours after plating and prior to supplementary chromate treatment?
3.1.14.2 Lot test per ASTM E8, Fig 8 with v-notch 4340 steel hydrogen embrittlement (for over 150kpsi): Is test performed?
3.1.14.3 Specimens: Subject to a sustain load 75% of the notched FTc for 200 hours.
3.1.14.4 Fasteners: Tested per Mil-Std-1312 (method 5 external and method 14 for internal fasteners) for 85% FTc for 72 hours.
3.1.14.5 Other Parts: (Pins, etc.) Sustained load for 200 hours?
3.1.14.6 Frequency of EES notch bar testing performed:_____ Months, by:
3.1.14.7 If not, describe alternate procedure(s) utilized:

3.1.15 Thickness:
3.1.15.1 For fasteners per locations in Mil-Std-1312-12 meet para. 4.6.1
3.1.15.2 Is the minimum thickness specified class 1, 2, or 3, and is the maximum thickness the minimum plus 0.003 inch?
3.1.15.3 If non-destructive thickness measurements are used, does documentation verify lot test measurements are made on actual parts instead of specimens unless a need has been demonstrated?
3.1.15.4 Are tests performed on parts sampled from each lot?
3.1.15.5 Which tests below are performed during lot acceptance?

- Electronic test per FED-STD-151, Method 520
- Magnetic test per ASTM B499
- Eddy current per ASTM B244
- Beta radiation backscatter per ASTM B56**
- X-ray spectrometry per ASTM B588
- Destructive tests
- Microscopic per ASTM B487 (400x)
- Coulometric per ASTM B504
- MIL-STD-1312-12
    1.) Drop test FED-STD-151, method--?
    2.) Magnetic FED-STD-151, method 522.1
    3.) Eddy Current FED-STD-151, method 520.1
    4.) Microscopic FED-STD-151, method--?
    5.) Dimensional changes (Go, No Go)
    6.) Anodic Dissolution (Kokour)
    7.) Strip & Weight

3.1.16 Adhesion:
3.1.16.1 At a magnification of 4 to 10 diameters does the plating show separation from the basis metal or underplating?
3.1.16.2 Production Control Test: Specimens are parts or specimens 1 x 4 x 0.04 inch. No separation when scraped by knife to basis metal or bent rupture and measured at 4x.
3.1.17 Corrosion Resistance:
3.1.17.1 Does the plating show white corrosion products after 96 hours salt spray?
3.1.17.2 Production control test: Specimens are parts or specimens 6 x 4 x 0.04 inch. Per ASTM B117 96 hours salt spray or MIL-STD-1312-1, for type II only.
3.1.18 Plating: Observations & Comments:

4.0 Elastomer Gasket & Seals Checklist

4.1 Raw material Controls:
4.1.1 Does supplier have in-house capability to verify all specified material characteristics?
4.1.2 If no, what outside lab(s) are used?
4.1.3 Are any raw materials sourced from outside the USA?
4.1.4 Does the supplier have controlled storage appropriate to the chemicals stored?
4.2 Process Controls:
4.2.1 Does supplier have a documented procedure to control batch-to-batch consistency?
4.2.2 Are the documented controls to insure repeatability of molding, curing, in-process storage?
4.2.3 Does supplier have the capability to adequately verify the physical and chemical characteristics of the finished product?
4.3 Age Control:
4.3.1 Does supplier have an integrated shelf life procedure applicable to raw materials, work in process, and finished products?
4.3.2 Does the supplier have a documented procedure for packaging the finished product?

5.0 Bearing & Bushing Checklist

5.1 Packaging
5.1.1 Does the supplier have a documented procedure for packaging the finished product to protect it from contamination or deterioration during storage?

5.2 Cleanliness
5.2.1 Does the supplier have adequate documented controls to insure the cleanliness of the finished product?

5.3 Lubricants
5.3.1 Review control for type and quality of lubricant impregnated in the finished product, where applicable.